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Elvin Charles Stakman: President of AAAS, 1949

Helen Hart, *University of Minnesota*

TO PLACE A SCIENTIST in an applied field of biology at the helm of the AAAS might have been considered utter heresy not so many years ago. Times change, however, and today both the academic and applied fields of all the sciences are filled with broad-visioned men dealing with theories, principles, applications, and the whole gamut of scientific experiences in relation to human progress. The Ivory Tower is obsolete largely because of the beliefs and activities of such men as E. C. Stakman, who is chief of the University of Minnesota's Division of Plant Pathology and Agricultural Botany and agent in the U. S. Department of Agriculture.

The new president of the AAAS, born May 17, 1885, in Algoma, Wisconsin, and educated in Minnesota, has the adventurous spirit of the Midwest. Life was never a bowl of roses to be admired and enjoyed for mere beauty. An education involved struggle, rigorous discipline, and sacrifice. Keenness of observation was to be sharpened by constant practice and intense interest in ordinary and extraordinary phenomena of everyday living. New ideas were to be entertained and carefully investigated. Intellectual integration of known facts and the ability to think clearly were worth many long hours of discussion and argument. The result is a vital, dynamic, stimulating personality eager for participation in numerous intellectual pursuits and tireless in efforts to enable other students the world over to contribute to human knowledge.

Stakman was graduated from the University of Minnesota in 1906 and was honored by election to Phi Beta Kappa. The M.A. degree was conferred upon him in 1910, and the Ph.D. in 1913. The honorary Doctor of Natural Sciences was awarded by the University of Halle-Wittenberg in 1938. He is a member of Sigma Xi, the National Academy of Sciences, the American Philosophical Society, the American Academy of Arts and Sciences, the Washington Academy of Arts and Sciences, and L'Académie Royale d'Agriculture de Suède. He holds honorary membership in the Sydney University Agricultural Society and the Canadian Phytopathological Society, and was instrumental in organizing the Mexican Phytopathological Society. He has served as president of The American Phytopathological Society, as chairman of numerous committees of that society, and as editor-in-chief of its journal, *Phytopathology*. He also has been American editor of *Phytopathologische Zeitschrift* and a member of the editorial committee of *Annual Review of Microbiology*. He is an active and forceful member of the Executive Committee of the National Research Council and the Advisory Committee on Biology and Medicine of the U. S. Atomic Energy Commission. He represents the AAAS on the Cooperative Committee on Science Teaching. Throughout his scientific life Stakman has been associated with the University of Minnesota and the U. S. Department of Agriculture. In 1930, however, he was visiting professor at the University of Halle-Wittenberg, and on numerous occasions he has undertaken special scientific or educational missions while on leave from the University.

The researches of Prof. Stakman and his colleagues have helped to lay foundations for many cooperative enterprises of plant scientists and agriculturalists. He has succeeded in coordinating controlled and precise experimental work in the biological laboratory with extensive and careful observations in Nature's laboratory. His researches on physiologic specialization within species of the rust fungi and on epidemiology of the cereal rust diseases elucidated the pathological principles basic to the synthesis of disease-resistant varieties of cereal crops for the vast grain-growing areas of the Mississippi Valley. His painstaking work on physiologic specialization of numerous fungi has influenced the biologist's concept of a species and has provided a better understanding of the biotypes and racial entities that make up a taxonomic species. Studies on barberries have emphasized the importance of the stem rust's alternate host as a source of inoculum for cereal hosts and as a breeding place for the fungus where new strains may arise, some of which may be far more dangerous than their progenitors. Stakman's researches on the smut fungi have opened the way for careful investigations concerning genetics of microorganisms, for the smut haplonts (1n) are easily cultured on artificial media for physiologic study and readily cross in the host plant to provide material for a study of the inheritance of various characters. His investigations in aerobiology were pioneer work—probably the first work in which airplanes were used to trap spores of microorganisms in the air. From that work have come numerous studies on the distribution of allergenic microorganisms, on the dissemination of plant pathogens over continental areas, and on protective measures to combat the introduction of new plant pathogens and pests.

Professional travel has characterized the career of

Prof. Stakman. While studying the cereal rusts, he undertook scientific missions to Europe, to Alaska, and throughout the United States and Mexico for the U. S. Department of Agriculture. Inquiry into disease problems of rubber production in Liberia and establishment of a research laboratory for the Firestone Plantations Company in 1930 necessitated travel in West Africa and also a survey of rubber production in the Far East. During World War II, in the interests of national defense in the Western Hemisphere, Stakman joined a Department of Agriculture Commission to study native rubber in South America and the possibilities of increasing *Hevea* rubber production there. In 1941 he was a member of the Rockefeller Foundation's commission to survey agricultural needs in Mexico, and two years later he helped in the implementation of the Foundation's program for agricultural improvement. More recently he has assisted the Foundation in a survey of agricultural problems and status of education and research in the natural sciences in various countries of Central and South America. Late in 1948 he became a member of a commission of scientists from the National Academy appointed to assist Gen. MacArthur in a survey of scientific research institutions in Japan.

While Dr. Stakman is known primarily as a plant pathologist and agriculturalist, he also is a renowned educator. Graduate students and postdoctorate fellows from every continent in the world have studied in his laboratories and have gained an insight not only into the scientific fields of biology and agriculture but also into the broad cultural life of an American university and the history and development of the peoples of the United States. They have found intelligent consideration and sympathetic understanding of their own national or racial cultures and intense interest in their present and future problems.

The honor and responsibilities of the Association's presidency for 1949 have been well placed in the scientist Elvin Charles Stakman.

Research and the Development of Atomic Energy

Robert F. Bacher, *Member, U. S. Atomic Energy Commission*

RESEARCH IS THE BACKBONE of the development of atomic energy. While the development of atomic energy also depends upon a host of technological improvements and upon the strength of industrial development and management, the guidance of research is a necessary requirement. Today, the research carried on under the atomic energy project ranges through physics, chemistry, metallurgy, the biological sciences, medicine, and most of the branches of engineering. The shortage of trained scientific and technical personnel, due at least in part to these greatly expanded activities, has prompted the Atomic Energy Commission to establish fellowship programs in the physical sciences and in biology and medicine and to set up technical training programs in radiation effects and the use of radioactive isotopes.

The main work of the U. S. Atomic Energy Commission is carried on in several Divisions: the Division of Production, which includes the production of raw materials from which fissionable materials are made and the production of fissionable materials themselves; the Division of Military Application, which covers the research, development, and production of atomic weapons; two Research Divisions, one for the physical sciences and one for the biological and medical sciences; and the Division of Reactor Development. In addition, there are, of course, many supporting activities which are an important and necessary part of the general administrative organization.

Most of the work in atomic energy is conducted by contract with industrial companies, universities, research organizations, and other government agencies. The greater part of it is carried out in installations especially erected for that purpose, although some of it is located in installations owned by the various contractors. The Atomic Energy Commission plans and coordinates this work. It is very important, for example, that work in the production of fissionable materials keep abreast of the developments of atomic weapons and vice versa, and that research in reactor development take account of recent experiences in the production of fissionable materials in reactors.

Since a large part of the work of the atomic energy project is carried on in several large installations, these installations have formed centers for management. At Oak Ridge, for example, there is a Manager who is responsible for all of the activities there as well as for several other contracts either closely associated with the Oak Ridge work or located nearby. Similarly, there are Managers at Chicago, where the

Address delivered at the November 18, 1948, meeting of the Washington (D.C.) Academy of Sciences.

Argonne National Laboratory is located; at Santa Fe, New Mexico, site of the Los Alamos Laboratory; at Richland, Washington, where the Hanford plutonium plant is located; and at New York, for the operation of the Brookhaven National Laboratory and many contracts associated with the procurement and processing of raw materials.

All of the major contracts of the Atomic Energy Commission are administered through one or another of these offices under the guidance of the various Divisions indicated above. Each of these Managers reports to one of the Division Directors in Washington whose responsibility covers most completely the work carried on by his office. These Division Directors report to a General Manager, who is responsible for carrying out Commission policy. Since every field office must carry on work in a large number of areas, a considerable amount of coordination is needed both by that responsible Division Director and by the Manager. It is the Commission's aim to have very close contact between the Planning Division in Washington and those working directly in the field.

The core of the Commission's work is the procurement and processing of raw materials, the production of fissionable materials, and their utilization either in nuclear reactors or in atomic weapons. As is well known, uranium plays a unique role as a raw material in the production of atomic energy. Natural uranium contains a small fraction—1 part in 140—of uranium of mass 235, which possesses the ability to produce nuclear fission with low-energy neutrons. It is this property, sometimes referred to as the property of nuclear inflammability, which allows one to make a nuclear reactor from natural uranium and graphite or from uranium and heavy water. Other materials, including thorium and the more abundant isotope of uranium of mass 238, are able to produce nuclear fission only with higher-energy neutrons and cannot by themselves maintain a nuclear chain reaction.

Since natural uranium has this unique property, it is a highly important element in the development of atomic energy. In the past, very little effort was put into the search for sources of uranium and into its extraction from low-grade ores. Prior to the development of atomic energy, uranium was used mainly for the extraction of radium and, once the radium had been extracted, was of little or no use. Gen. McNaughton, of Canada, once told me that when he became president of the National Research Council of Canada in 1935, one of his first problems was how to utilize the large amounts of uranium from which the radium had been extracted. That little problem seems to have been solved.

Today, our ideas of the amount of uranium available in the world are necessarily fragmentary. The intensive search for uranium has just begun. In the past, only high-grade deposits were mined; now, new information is being sought on how uranium may be extracted from low-grade ores, and at the same time the location and assessment of low-grade ore bodies are being determined. An intensive effort is being made in this direction, and it accounts for one of the major lines of research and development at present.

Under the general category of production, uranium ore is processed, purified, and made either into uranium hexafluoride for use in the diffusion plants at Oak Ridge or into uranium metal for insertion in the nuclear reactors at Hanford. Each of the steps in this process has been subject to a great many changes as a result of research and development and, indeed, the production of uranium hexafluoride and the production of uranium metal were, in their earliest stages, research processes.

One of the major aims of the production program is to obtain a purified fissionable material, since this can be used either in a variety of nuclear reactors or for the production of atomic weapons. One method of obtaining fissionable material is to separate uranium 235 from the natural uranium by a gaseous diffusion method which was developed during the war and put into operation in 1945. For this purpose a very large plant was constructed at Oak Ridge. This plant contains miles and miles of piping and many hundreds of pumps. The separation of uranium 235 from uranium 238 is accomplished in a very large number of steps and depends essentially upon the fact that, due to its smaller mass, a molecule of uranium hexafluoride (UF_6) containing uranium 235 has a slightly greater chance of diffusion through a tiny hole than one containing uranium 238. As you may guess, this probability is not much greater, and the operation must be conducted many times in order to achieve any sensible separation of isotopes. That this is a practical method of isotope separation is a tribute to technology and industry. Of course, research has played a tremendous role in the development of the gaseous diffusion method, and today, a great amount of process development is going on which constantly improves the efficiency and reliability of the operations.

Another method of isotope separation which was pursued vigorously during the war is the electromagnetic method. Here the separation of isotopes depends upon the curvature of the paths of ions of different masses in a uniform magnetic field. It is the old principle of the mass spectrograph used on an industrial scale. Today, the plant constructed at Oak Ridge during the war for the separation of uranium isotopes by the electromagnetic method is largely in

stand-by condition. Work on new developments is going forward, however, and a small part of the wartime installation is operated to test new improvements. In addition, the research and development work on separation of uranium isotopes by the electromagnetic method is coupled with the separation in small amounts of the isotopes of many other elements. Small quantities of these are needed in many cases to sort out the nuclear properties of the various isotopes, since these nuclei are as different one from another as those of ordinary atoms. Some of these separate stable isotopes are important as tracers, but more of that later.

Several other methods of isotope separation were explored during the war, and some of them were actually acted upon and plants constructed. A thermal diffusion plant was operated for a short time at Oak Ridge. Research and development work on the separation of isotopes by a centrifuge method was undertaken, but no plant was ever constructed. New means for the separation of isotopes beyond those already tried or now in active use depend upon fundamental research for their foundation.

The production of fissionable materials in a nuclear reactor is accomplished in a very spectacular way. The whole idea of a nuclear reactor and the operation of a self-sustaining nuclear reaction is, indeed, a revolutionary one. Since the first self-sustaining nuclear reaction was achieved at the Metallurgical Laboratory in Chicago, just about 6 years ago, several reactors for research, development, and production purposes have been constructed. Nuclear reactors were developed during the war solely for the purpose of producing a new element—plutonium—which is a fissionable material and may, therefore, be used as an ingredient for the production of atomic weapons. Plutonium is produced from the excess neutrons which are generated in the fission process. Some of these neutrons produce more fissions in uranium 235; others are absorbed by the uranium 238, producing uranium 239, which is radioactively unstable and emits two beta particles one after the other, becoming plutonium—element 94, mass 239. In order to produce plutonium, even in small quantity, a large number of fissions must take place. Since each nuclear fission produces an amount of energy roughly 2,000,000 times that produced in the combustion of a hydrocarbon molecule, the production of plutonium is accompanied by the liberation of large quantities of energy. So far, this energy has been wasted, but potentially it may be very useful. The large reactors constructed at the Hanford plant, out on the Columbia River, are plutonium producers. The considerable quantity of energy which they produce from nuclear fission warms the Columbia River slightly but is put to no constructive use.

After uranium has been irradiated for some time in the nuclear reactor or pile, it becomes highly radioactive with fission products and also contains a very small amount of plutonium. In order to separate this from the fission products in uranium, a rather elaborate remote-control chemical plant is needed. This separation would not be extraordinarily difficult if this material were not highly radioactive. But to operate a complicated plant without being able to get into it at a critical time poses many problems. Research and development have not only been the foundation for the construction of nuclear reactors but have played an important role in the many developments which have taken place in the chemical processing.

The development of the first atomic bomb required research into properties of fissionable materials and a rather imposing amount of development work. Since that time, research and development on weapons have been carried on at the Los Alamos Laboratory, and many new facts about weapons have been learned. This work has led during the past year to successful tests of several newly developed weapons which were carried out in the Pacific last spring. The research and development carried on in connection with the weapons work ranges all the way from fundamental work in nuclear physics and chemistry to weapons development work and ordnance engineering.

A recent example of fundamental work at Los Alamos is, I believe, of unusual interest. Using a very small quantity of helium of mass 3, the condensation of that material was recently achieved. This is a point of considerable scientific interest because the properties of the condensed He^3 were expected to be very different from those of normal helium of mass 4, and it was even thought by some that it might not be possible to condense this material. It does, indeed, show quite different properties from ordinary helium at these low temperatures. The boiling point of He^3 is observed to be 3.19° above absolute zero compared to 4.3° for normal helium, and its vapor pressure at low temperature is very much greater than that observed for He^4. At 1.2° K, the vapor pressure is 35 times that observed for normal helium.

He^3 has been found to occur in very small amounts in natural helium. It is also obtained by the radioactive decay of hydrogen of mass 3, or tritium, which can be produced by the bombardment of lithium in a nuclear reactor. Both of these isotopes, which are of unusual interest for nuclear experimentation, have recently been made available in small quantities as part of the Commission's isotope distribution program. As you may know, the nuclear magnetic moments of both He^3 and H^3 have recently been studied and determined with some precision. The nucleus of H^3 is the sim-

plest one showing radioactive decay. It has a half-life of 12 years, and the maximum energy of the beta particle is now believed to be about 18 kv. Recent measurements of the maximum energy of the emitted beta particle and of the half-life now make it appear that there is no serious disagreement with the theoretically expected relation between these two quantities. In spite of the extreme softness of this radiation, it now seems likely that H^3 may be extraordinarily useful as a tracer isotope.

Research and development work which is not directly connected with the production of fissionable materials or the development and production of atomic weapons forms a large part of the program of work in physical science research, biological and medical research, and in the development of nuclear reactors.

The Commission has a major program of research in biology and medicine. This was first undertaken during the war in connection with the production of radioactive materials and the health hazards accompanying them. It was soon found that, in addition to health problems, there were many inadequately understood medical and biological problems which arose due to the unknown effects of these radioactive materials. During the war, work in these fields was confined largely to that absolutely necessary for the production programs under way. Very little was done to understand the effects of radiation upon living cells.

The health work is now carried out on an even greater scale, since many more problems have arisen in connection with new methods of chemical processing and the greatly increased use of radioactive materials. In addition, a great deal of work is directed toward a better understanding of the effects of radiation upon living matter, and these studies include fundamental research in biology and medicine. Work is now under way to study the way in which radioactive materials are concentrated in various parts of the body, and similar studies have been made on plants.

Radioactive isotopes, which are proving to be an important means of finding new information in many sciences, are of particular importance in the complex problems in biology and medicine. Today, biological and medical workers are by far the greatest users of radioactive isotopes, and the possibilities are growing every day. Work now in progress in the biological sciences ranges from fundamental work on photosynthesis to practical problems on the use of fertilizers. It would be very difficult to overestimate the benefits the world could get from a better understanding of the processes by which plants accumulate solar energy.

An example of the medical uses of radioactive isotopes is some recent work at Tulane University. A study was made of patients with congestive heart failure. Due to the deficiencies in the pumping action of the heart, the saline solution of the blood backs up in various parts of the body, the lungs become water logged, the liver swells up, and there is a general condition of dropsy. By using radioactive sodium, it was definitely shown that the excretion of sodium was subnormal, and a drug was found which increases greatly the salt excretion and relieves the dropsy.

Another example is the work at Columbia University, where radioactive iodine has been used as a diagnostic aid in determining whether patients have a thyroid disorder. Radioiodine has also been used with success in many cases in the treatment of hyperthyroidism, and the same radioisotope has been used in radioautographic studies of primary thyroid cancer to give information which would point to possible therapy. These are but a few examples of the extensive use of one radioactive isotope in medical work.

Sometimes the work in radiation effects leads to an unexpected result. Since the plutonium production reactors are located on the Columbia River, attention has been directed toward studies of salmon. Dr. Donaldson, head of the School of Applied Fisheries at the University of Washington, has found in the course of these studies that new spawning grounds can be successfully established by the transplanting of spawn to suitable pools not previously used.

The work in biology and medicine is carried on in the various National Laboratories at Brookhaven, Oak Ridge, and Argonne, as well as at Rochester, Los Alamos, Berkeley, and at a very large number of universities and medical schools. The Commission is also supporting the Atomic Casualty Survey, a study made of the casualties suffered from the bombs dropped upon Hiroshima and Nagasaki.

In the physical sciences the work supported by the Atomic Energy Commission is predominantly in the fields of physics, chemistry, and metallurgy, although much of this work branches into the engineering phases of these sciences. A great deal of the work in the physical sciences, however, is directed toward fundamental research, since an effort is being made to encourage fundamental work in nuclear science, both in order to obtain a more complete understanding of the atomic nucleus and to provide trained scientists who may later take up applied work in atomic energy.

Our understanding of the atomic nucleus is today all too inadequate. While we have learned how to obtain energy in quantity from certain atomic nuclei, we do not know the origin of the forces holding the atomic nucleus together, and we have no explanation of most of the observed properties of atomic nuclei, such as their angular momenta and magnetic moments. In-

formation on nuclear properties is now being added at an ever-increasing rate, and today, many fundamental properties of nuclei are known of which we were ignorant three years ago.

There have also been many exciting experiments with cosmic rays and with high-energy particles accelerated in giant machines. During the past year, the first man-made mesons were produced in the big cyclotron in Berkeley, and now it seems that there are probably several kinds of these intermediate mass particles which are produced by high-energy particles. Work upon these fundamental particles of physics is being carried on in Commission-supported laboratories and under a number of contracts with universities which have been supported jointly by the Commission and the Office of Naval Research.

The requirements of nuclear reactors have posed many interesting and difficult problems. Due to their unusual ability to absorb neutrons, it has become necessary to separate rather completely some elements from various materials with which they are usually found and in which they have frequently appeared as impurities because of their similar chemical properties. In some cases it has been necessary to reduce the content of such impurities in reactor materials to a fraction of a part per million. The effects of radiation upon materials in nuclear reactors have prompted a vigorous investigation of the solid state characteristics of certain materials. The whole subject of the solid state is, indeed, a difficult one, and the radiation effects upon materials are today only very incompletely understood. These effects constitute one of the major problems in reactor development, and some further basic understanding will certainly be necessary in the course of this development. The requirements of reactors have also led to the development of several new metals which have not been used previously due to their difficulty in preparation but which may prove to be the structural materials of the future.

The development of nuclear reactors is a subject which is just beginning to come into its own. At the end of the war, the optimism about the development of atomic power struck everywhere, and the technical difficulties were only just beginning to be understood. For example, radiation effects upon materials in reactors had been anticipated, but the seriousness of these effects and the difficulties to which they might lead were only partially foreseen. Radiation effects soon proved to be a reality, and the difficulties to which they led were serious. It became necessary to backtrack considerably in reactor development in order to take account of these effects.

The chemical problems of reprocessing nuclear fuel, or of extracting plutonium from irradiated uranium, have likewise proved to be a major headache. These chemical processes are costly and complicated, and involve tremendous outlays in plant. Disposal of the radioactive wastes obtained from these chemical plants has proved to be extremely difficult. During the past two years, considerable progress has been made in the development of new chemical processes which may prove to be more efficient and which may help in the disposal problem. The disposal of these products, which have sometimes been referred to by the uneuphonious name of atomic garbage, is much more difficult than the disposal of ordinary industrial wastes.

These hurdles in the development of nuclear reactors seem now to have been partially cleared, but we can by no means conclude that the production of electrical power from nuclear reactors is technically feasible, let alone economically feasible.

It seems very likely that new developments will make the production of electrical power from nuclear reactors technically feasible. But exactly how complicated such a plant will be and what its efficiency may be are points which are pretty much unknown. There are, indeed, whole sections of this work that are unexplored. For example, we know that the efficiency of a heat engine depends upon the difference in temperature of the thermal cycle. Nuclear reactors today operate at relatively low temperatures; thus, the temperature difference measured on an absolute scale is indeed small, and the efficiency necessarily low. In order to achieve higher efficiency, it will be necessary to operate nuclear reactors at much higher temperatures. This involves many technical developments, some of which may prove to be desirable for other reasons as well, but much new work is necessary.

The question of economic feasibility is one on which we can only speculate. It is true that various papers have been written on this subject, but it seems most unlikely that the question of economic feasibility can be sensibly commented upon until the technical situation is considerably clearer. We should remember, however, that the course of any new development, once its outlines have been clarified, is always to simplify and thus cheapen the process. Although the development of electrical power from nuclear reactors looks complicated and questionable from the economic standpoint, we can expect that future work will make this development considerably more favorable. In spite of this, it is far too early to make any predictions about the economic feasibility of atomic power.

On the technical side, the situation is much more promising but the developments are going to take some time. On a demonstration basis, electrical power will probably be developed from a nuclear reactor within the next two years. Within the next 8-1

years there will probably exist a prototype of a nuclear reactor for the production of electrical power in quantity. This unit, of course, will be preceded by smaller units. Two of these are now being designed and will soon be under construction, one at the Argonne National Laboratory and the other at the Knolls Atomic Power Laboratory near Schenectady.

Of course, the whole development of economic electrical power from nuclear reactors is but one aspect of reactor development. For some purposes, such as the propulsion of a ship, the nuclear reactor has peculiar advantages from the fuel standpoint. Here, the question of size, weight, and complexity of the nuclear reactor and its auxiliary equipment are of paramount importance. While no reactor, operating at the temperature presently used, could possibly prove to be a useful source of power for such a purpose, the use of higher temperatures may reasonably be expected to lead, in the not too distant future, to reactors which are suitable for this purpose. Whether or not the characteristics of such reactors are such that they will prove to be useful sources for ship or submarine propulsion will have to await the outcome of the development work. At the present moment, the prospects in this direction look favorable, and it seems likely that this will be the first application of a mobile nuclear reactor.

Many people have speculated upon the possibility of driving an aircraft by a nuclear reactor. Here there are many intriguing possibilities because of the extraordinary large energy content per pound of purified nuclear fuel. Unfortunately, nuclear reactors as we now know them are heavy. In particular, the shields for protection from the penetrating radiations produced inside must be very thick and heavy. Furthermore, the temperatures needed for aircraft nuclear reactors will probably need to be much higher than those which might be tolerated for driving a ship. In short, the problems here seem to be much more difficult.

The other day I read in a newspaper that someone had said that the theoretical work for the construction of a nuclear-powered aircraft was 99% complete. Probably he was misquoted, since there are certainly some important scientific problems yet to be solved. But the development of a nuclear-powered aircraft is primarily a technical and engineering problem—not a scientific one. Whether such a development will prove to be feasible can be determined only if a very great amount of new technical work is done.

In this connection it is interesting to note that the B-29 which was first used in combat in the later stages of the war was being designed prior to the discovery of nuclear fission. It took just about the same time to go from the discovery of nuclear fission through the production of experimental, pilot plant, and production chain reactors, through the extraction of purified fissionable material, to the development and construction of the atomic bomb that it took to proceed from the design of the B-29 to its actual use. This is by no means due to any lack of ingenuity and industry on the part of airplane manufacturers, but rather to the enormous complexity of the technical and construction problems which must be solved to make an airplane or airplane engine. We cannot expect the nuclear-powered aircraft to appear in the next few years, even if further work does indicate that it is feasible.

One of the most exciting prospects in the development of nuclear reactors is the possibility that one may be able to consume fissionable material, obtaining energy from this process, and at the same time utilize the neutrons thus produced to generate a larger amount of fissionable material than was destroyed. This subject is now being actively pursued. Whether or not it will be possible to achieve is not yet clear. In order to be practical, it will also be necessary to develop highly efficient chemical treatment of the nuclear fuel which must be reprocessed from time to time. It is a very intriguing possibility, and since the amount of new material which can be produced will depend both upon the intrinsic rate of production in the reactor and the amount of fissionable material thus committed, our stock of fissionable material may prove to be an even more precious possession than it seems today.

As you can see, research enters into almost every phase of atomic energy work. There is no sharp distinction between research and development. While there are a few examples where fundamental research can be set off by itself, it is more usual to find that development work often produces new leads for fundamental research and fundamental research shows the way to new possibilities for development and practical utilization of atomic energy.

Much has been made over the point expressed by some that atomic energy is of use only as an instrument of destruction. It is certainly true that our introduction to atomic energy was through the operation of the plutonium production reactor and the development of the atomic bomb. All work during the war was aimed at the development of the atomic bomb, but in the past three years we have seen the actual start of work in many other directions. The future holds quite a different picture. I believe that only those of myopic vision today believe that the long-range developments of atomic energy will not in time contribute very greatly to man's general well-being and cultural advancement if he can but stir up the wisdom needed to handle the tremendous forces which have been unleashed.

Preliminary Investigations of Chromosomes and Genes With the Electron Microscope

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A RELATIVELY SIMPLE METHOD of cutting and mounting sections sufficiently thin for effective use with the electron microscope was recently described by the present authors (*Proc. Soc. exp. Biol. Med.*, 1948, 67, 470). Section 0.2 μ thick were described originally, but with practice and minor improvements, 0.1-μ sections often have been obtained. We have started to apply this technique in a study of chromosome structure. Work has been initiated with the salivary glands of *Drosophila melanogaster*, fixed in the conventional manner by removing the glands directly within an acetocarmine mixture. This mode of fixation proved to be rather better than we had anticipated, even at the highest magnifications.

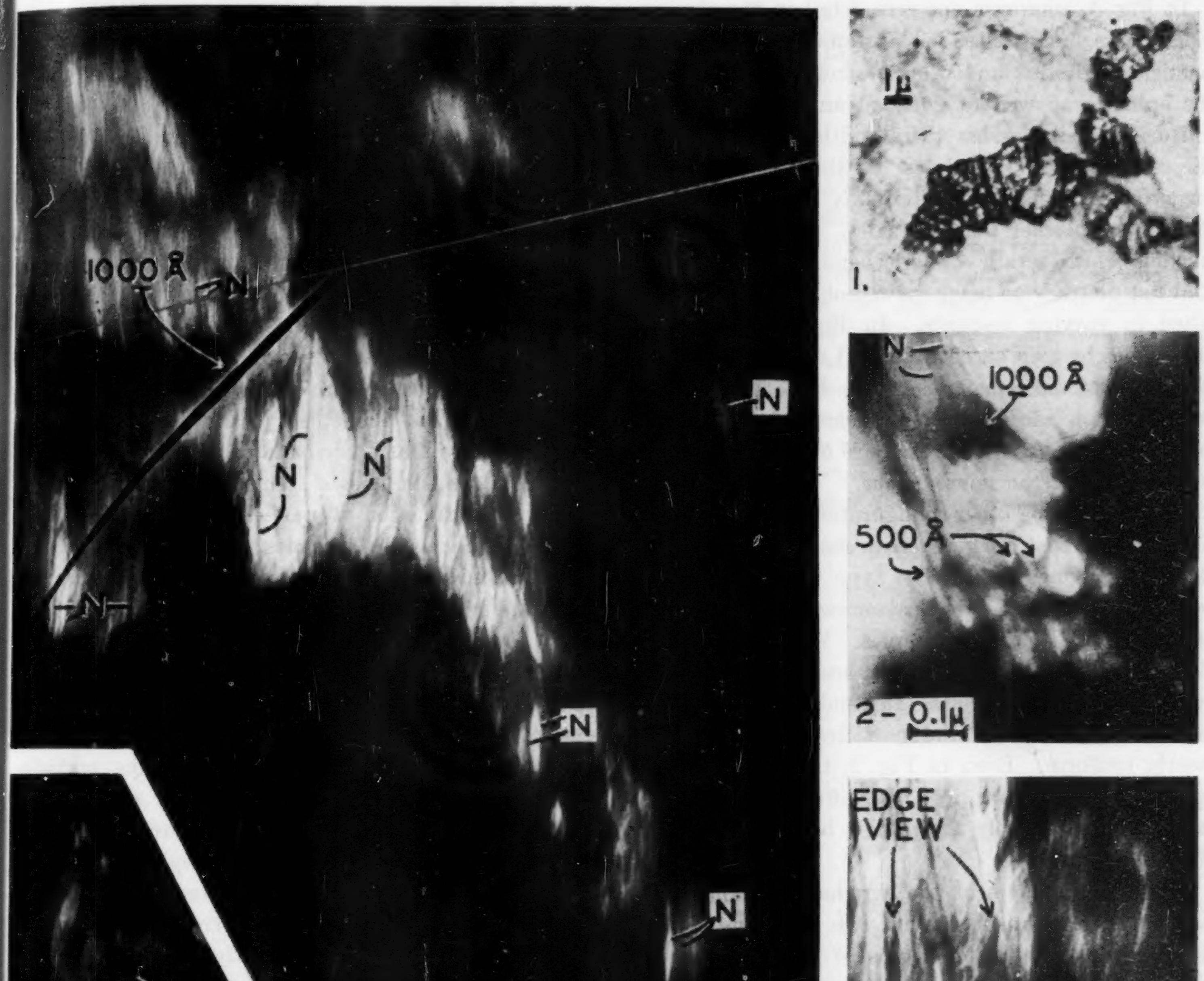
Before proceeding, it may be well to point out the known salient features of salivary chromosomes for those who are not familiar with their highly specialized organization. These are not ordinary chromosomes with single chromomere granules spaced along a single chromonemal thread. Instead, each primordial chromosome has reduplicated itself many times over. The end-product is a giant multiple chromosome made up of hundreds, if not thousands, of identical units.

Work with low magnifications disclosed particularly that the chromomere bands were very dense—far denser than any other cellular constituent. One has only to glance at Fig. 1 to be impressed with the difference between the substance of the chromomeres and the nucleoplasm. Since the electron image is a function of atomic and molecular density, it is possible to state definitely that chromomeres cannot have much water within them. The great density of the chromomeres has, in fact, been a major source of difficulty in attempts to employ high magnifications to resolve their structure. Excellent detail could be seen in any portion of a 0.1-μ section except within chromomeres. The latter have been visualized effectively only when their thickness was substantially less than 0.1 μ. This has occurred at the edges of sectioned chromosomes where their substance tapered (as in Fig. 2), or when sections had pulled apart somewhat to produce particularly thin areas (as in Fig. 4). Under those circumstances chromomeres have been resolved into their unit particles.

It will be convenient to begin our detailed discussion with Fig. 3, which shows a chromosome at moderate magnification for the electron microscope. The general relations show well, although fine detail is lacking. Chromomere granules arranged in bands are readily visible, the larger ones, however, being opaque to the electron beam. The lighter bands contain smaller granules usually aranged more diffusely. In one region, isolated 800-A particles are visible. The matrix is coarsely vacuolated—undoubtedly a fixation artifact, for the proteins of any greatly hydrated portion of a cell always are precipitated as a fibrous net. Between the vacuoles a mesh of relatively heavy fibers exists, too large and irregularly arranged to be identifiable directly with chromonemata. This figure shows most of the relations (and artifacts) that can be seen readily. One point that can be established definitely at this magnification is the fact that no limiting membrane can be found at the surface of the chromosome.

Under circumstances outlined earlier, detail was seen within chromomeres, but micrographs showing this clearly have been rarities. The remaining discussion will be based upon about a dozen pictures, although many more suggest and confirm the relations to be considered. Figs. 2 and 4 have been chosen to illustrate the unit particles of chromomeres, but some discussion of their general relations seems necessary. Fig. 2 was from the edge of a chromosome. Three completely dense chromomere bands can be seen to the right. To the left, 500-A particles in isolation, and also a small cluster of 1,000-A particles, can be seen. The larger particles were quite obviously related to a much heavier band than were the smaller ones.

Figs. 4, A, B, and C, are the most revealing electron micrographs obtained so far. The original micrographs have a resolution of at least 30 A, although detail is lost in reproduction. All are of the same preparation, but unfortunately, the plane of section was quite oblique to the long axis of the chromosome. The individual bands tend to be shingled, one overlapping the next. The course of the bands is nearly horizontal, as can be seen in 4B and at the upper left of 4A. The section was actually rather thick, but clefts opened to disclose thin areas.



Electron micrographs of *Drosophila* salivary chromosomes: Fig. 1, × 3,600; Fig. 2, × 76,000; Fig. 3, × 49,000; Fig. 4, × 120,000. Chromonemata are designated by N. Particle lengths are expressed in Angstrom units.

In Fig. 4, wherever one sees detail in the chromomere bands, one gets the impression of spindle-shaped particles. In this and other micrographs, whenever the spindles showed to good advantage, they had a uniform density across their width, indicating that the particles were flat plates. If they had had circular cross sections, the center axis would have been denser and blacker than the sides. Variations in the particle width within a single band further suggests that flat plates were being viewed obliquely, as though tilted in varying amounts. In Fig. 4C a few are thought to be seen on edge. The 1,000-A particles of Fig. 2 are of the same leaf shape. In fact, this seems to be very decidedly the most common type of unit particle which has been seen more or less clearly in a number of electron micrographs.

Particles having other configurations have been seen, however. These were globular in character rather than flattened in one plane. The type we have observed best and most often was asymmetrical. The 500-A particles of Fig. 2 are examples. We have good evidence of cigar-shaped particles, and others appeared to be essentially spherical. It should be stressed that within any one band the particles appeared to be nearly uniform. Even in Fig. 2, the small particles were presumably identical, the difference in appearance resulting simply from their being viewed from different angles.

The unit particles of the chromomere bands quite certainly were not of constant size from one band to another. Approximate lengths of some that can be measured most accurately are indicated on the figures. Because of the oblique section of Fig. 4, the lengths there may be deceptively low. Particles ranging up to almost 1,500 A have been seen in other micrographs. Particles of 500 A are the smallest that have been seen clearly, although there is some reason for believing that somewhat smaller ones exist. The particular particles of the left center of Fig. 4C are of about average size—approximately 750 A long and not more than 80 A thick. Although their width cannot be determined very accurately, it is probably about 250 A. The particle volume would therefore be of the order of $10^7 A^3$.

We have seen enough electron micrographs to realize that the grosser morphology of the bands is to some extent a reflection of the character of their unit particles. Particles of different shape apparently tend to aggregate in different manners. The most striking example is a very regular and uninterrupted alignment of cigar-shaped particles which has been observed to produce a band that would appear as a sharply defined, nongranular line in the light microscope. The leaf-shaped particles often were seen aggregated to form rather large granules, more or less fused with one another. This is the type of dense band visible in Fig. 3 and would definitely appear coarsely granular in the light microscope. Globular particles usually were observed only in small aggregates (Fig. 2 is an exception). The small granules so formed tended to exist in isolation and to be scattered. The light microscopist would see such bands as diffuse structures, very finely granular. No doubt other as yet undiscovered relations exist, and the time may come when these can be expressed more precisely.

There is an interesting corollary of these findings. Since the chromomeres are composed exclusively of the unit particles, and since theory (and our own observation) demands that every band contain the same number of units, the volume of stainable material in a band should be a function of particle size. If these particles can be identified as genes, gene size probably can be estimated with the light microscope.

Before leaving the discussion of the unit particles, it will be wise to consider the possibility of fixation artifact. The degree and kind of artifact cannot be established with certainty without much further work employing other means of fixation and probably lyophilizing techniques. However, since the particles which have been observed had complex shapes, they cannot be dismissed lightly. Furthermore, these shapes are related to what the light microscopist can observe in living material as well as in fixed preparations. Finally, we have presented incontrovertible evidence that the particles are not greatly hydrated, so that there is no reason to expect major changes. The principal artifact may well amount to nothing more than some shrinkage.

We have emphasized that the hydrated matrix of the chromosome was not well preserved; we believe, nevertheless, that we often have seen chromonemata. In electron micrographs with good resolution thin fibrils commonly were seen extending away from unit particles toward adjacent bands. Usually they were attached to the tapered tips of particles, but the globular particles sometimes seemed to be attached at one side. A few micrographs showed these filaments in great profusion. Under favorable circumstances, a single fibril could be traced from a particular particle of one band to one of the next as in Fig. 4B. Where these fibrils are most conspicuous in the figures, they have been designated by the letter N. No clearly defined chromonemata have been observed that were thicker than about 80 A. The thinner fibrils, probably stretched, were sometimes less than 50 A thick.

Even though this work must be regarded as in its early stages, we have been impressed by the close

(*Continued on page 22, column 2.*)

TECHNICAL PAPERS

Effect of Absorber Position on Counting Rate of Collimated and Uncollimated Beta and Gamma Radiation[1]

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Although it is generally recognized that, because of scattering effects, the observed counting rate of a radioactive sample depends on the atomic number and geometrical arrangement of absorbers and surrounding material (e.g. *1–9*), we do not know of any published data which show how greatly the counting rate may depend on the position of an absorber foil placed between a fixed sample and detector. The data of Tables 1 and 2 illustrate this dependence and the fact that a variation in absorber position in a collimated beam of radiation may have an effect opposite to that of a similar variation in position in uncollimated radiation. These effects may be explained with the aid of the schematic diagram given in Figs. 1 and 2.

TABLE 1

EFFECT OF POSITION OF ABSORBER ON THE COUNTING RATE OF UNCOLLIMATED RADIATION FROM A RADIOACTIVE SAMPLE

Test*	Type of radiation	Absorber	†Distance (cm) of bottom of absorber from: Sample	G-M tube window	Cpm*
1	Beta, 1.69 Mev, max.	109 mg/cm² of Pb	0	5.4	3,712
			1.5	3.9	3,200
			3.0	2.4	2,528
			4.5	0.9	1,856
2	Beta, 1.69 Mev, max.	120.7 mg/cm² of Al	0	5.4	6,368
			1.5	3.9	5,568
			3.0	2.4	4,512
			4.5	0.9	4,288
3	Gamma, 1.3 Mev and 1.1 Mev	920 mg/cm² of Pb	0	5.4	2,052
			1.5	3.9	1,577
			3.0	2.4	1,377
			4.5	0.9	1,134
4	Gamma, 1.3 Mev and 1.1 Mev	870 mg/cm² of Al	0	5.4	2,040
			1.5	3.9	1,557
			3.0	2.4	1,318
			4.5	0.9	1,233

* Different radioactive samples and different Geiger-Müller tubes were used in different tests, so the relation of the absolute counting rates of different tests has no significance.

† Fig. 1.

[1] The work reported here has been supported in part by the Research Committee of the Graduate School from funds supplied by the Wisconsin Alumni Research Foundation.

In the case of the collimated beam (Fig. 2) a certain fraction of the radiation, represented by A, is transmitted through the absorber without scattering regardless of the position of the horizontally placed absorber between the sample and the detector. The remaining radiation is scattered with an angular distribution which is independent of the distance of the absorber from the detector window, but the fraction of such radiation entering the window is dependent on this distance. This is illustrated by the radiation labeled B_I, which is scattered from an absorber in position I at such an angle that it does not enter the detector window, while the identical radiation, B_{II}, scattered at the same angle from an absorber in position II, does enter the window.

TABLE 2

EFFECT OF POSITION OF ABSORBER ON THE COUNTING RATE OF COLLIMATED RADIATION

Test*	Type of radiation	Absorber	†Distance (cm) of bottom of absorber from: Lead block	G-M tube window	Cpm*
1	Beta, 1.69 Mev, max.	50.7 mg/cm² of Pb	1.5	5.8	312
			3.0	4.3	425
			4.5	2.8	661
			6.0	1.3	1,045
2	Beta, 1.69 Mev, max.	120 mg/cm² of Al	1.5	5.8	369
			3.0	4.3	491
			4.5	2.8	737
			6.0	1.3	1,185
3	Gamma, 1.3 Mev and 1.1 Mev	465 mg/cm² of Pb	1.5	5.8	672
			3.0	4.3	672
			4.5	2.8	704
			6.0	1.3	832
4	Gamma, 1.3 Mev and 1.1 Mev	445 mg/cm² of Al	1.5	5.8	704
			3.0	4.3	720
			4.5	2.8	736
			6.0	1.3	848

* See Table 1.

† Fig. 2.

When the radiation is not collimated (Fig. 1) the effect illustrated in Fig. 2 still occurs for those radiations in the direct cone of the solid angle subtended by the counter window, but a larger effect, due to the decrease in the total amount of radiation intercepted by the absorber as it is moved from the sample toward the detector, is superimposed. This is illustrated by the radiation labeled C_{IV}, which escapes the absorber and counting tube completely when the absorber is in position IV but which has a certain probability of being scattered along the direction C_{III} and entering the detector if the absorber is in position III.

The effect of absorber position depends, of course, upon area and thickness of the absorber, energy of the radiation, and degree of collimation of the beam. Under some conditions a minimum in the counting rate may occur as the absorber is moved from the sample toward the detector. A specialized case of the effect illustrated in Fig. 1 is the "self-focusing" which often leads to an initial increase in counting rate of a radioactive sample of constant disintegration rate as it is diluted with inactive material.

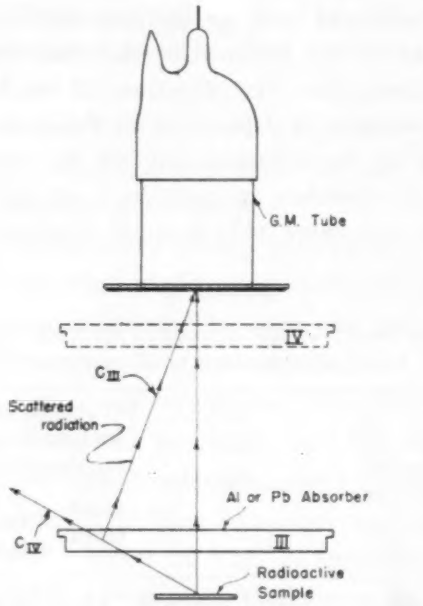

FIG. 1. Illustration of the effect of the position of an absorber on the counting rate of uncollimated radiation.

A radioactive sample mounted as in Fig. 1 gives a lower counting rate through a pile of thin absorbers placed loosely on top of the sample than through a single thick absorber of the same total surface density. For example, when an 1,850 mg/cm^2 lead absorber in uncollimated gamma radiation from Co^{60} was replaced by 5 single absorbers of thicknesses 916, 434, 234, 234, and 36 mg/cm^2 totaling 1,854 mg/cm^2, the counting rate fell from 1,260 cpm to 924 cpm. This is presumably due to the greater average distance from the sample of the absorbing material in the loosely piled absorbers and a consequent decrease in scattering of the type illustrated in Fig. 1.

Since most radioactive tracer work requires only a knowledge of the relative counting rates of samples which can be counted under nearly identical conditions, the phenomena discussed here need not be a serious handicap in such investigations.

The data of Table 1 were obtained using an unshielded, brass, bell-shaped, Geiger-Müller counter tube mounted in a conventional Lucite stand provided with slots for reproducibly placing samples and absorbers. The $1\frac{1}{8}''$-diameter mica window of the tube was 5.4 cm from the radioactive sample spread on a 1" watch glass resting in a cardboard holder, the backing of which was the wooden desk. The data of Table 2 were obtained in the same manner, except that the radioactive sample was placed at the bottom of a hole 1.5 cm in diameter and 15 cm long in a lead block. The distance from the counter window to the top of the lead block was 7.3 cm, and the geometrical relationships were such that the diameter of the collimated beam of radiation at the counter window was less than the diameter of the window.

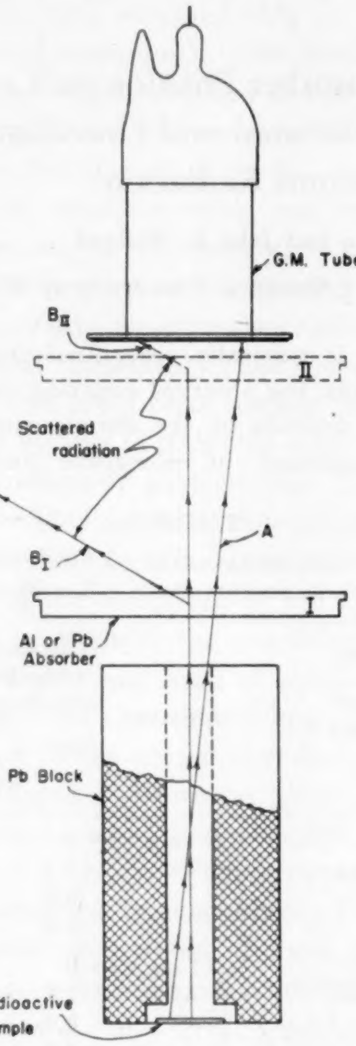

FIG. 2. Illustration of the effect of the position of an absorber on the counting rate of collimated radiation.

Tests of the effect of absorber position on the counting rate were made with both aluminum and lead absorbers ($2\frac{1}{2}'' \times 3\frac{1}{4}''$ in area) with both the beta radiation of P^{32} (1.69 Mev, max. energy) and the gamma radiation of Co^{60} (1.1 and 1.3 Mev). The absorbers used were thick enough to cut out the 0.3-Mev Co^{60} beta radiation.

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Oxidation of Parenterally Administered C^{14}-labeled Tripalmitin Emulsions[1]

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The question whether long-chain fatty acids can be utilized when administered by routes other than the gastrointestinal tract has aroused considerable interest in recent years. Dunham and Brunschwig (*2*) failed to observe protein-sparing effects in 9 of 11 dogs when a highly emulsified fat was injected intravenously for periods as long as one month. The emulsions used, however, were quite toxic. McKibbin, *et al.* (*4*), on the other hand, have drawn the conclusion that intravenously administered emulsions of fat are utilized, for not only did they find weight improvement and nitrogen retention in 2 dogs, but, in addition, they were unable to account for a considerable portion of the infused fat by finding it stored in an unmodified form. Meng and Freeman (*5*) also noted a gain in body weight in dogs that received fat emulsions intravenously, but they point out that such results furnish no direct proof of fat utilization.

The use of radioactive carbon provides for the first time a direct method for determining whether an animal can convert parenterally administered fatty acids to CO_2. Palmitic acid containing C^{14} in the sixth carbon atom

$$C_{10}H_{21}C^{14}H_2CH_2CH_2CH_2CH_2COOH \qquad \text{(I)}$$

(I) was synthesized as described in an earlier communication (*1*) and then esterified with glycerol by a modification of the method of Feuge, *et al.* (*3*). An emulsion of the tripalmitin was prepared with glycerol monostearate as the stabilizer and the fat dispersed into particles of less than 2 μ by means of supersonic energy. One or 1.5 cc of this emulsion containing 25 mg of tripalmitin was then injected into the foot vein of fasted rats weighing 175 gm. The expired CO_2 was collected and its C^{14} determined. Typical results are shown in Table 1.

TABLE 1

RECOVERY OF C^{14} IN THE EXPIRED CO_2 OF A RAT INJECTED INTRAVENOUSLY WITH A FAT EMULSION CONTAINING TRIPALMITIN IN WHICH THE PALMITIC ACID WAS LABELED WITH C^{14}*

Interval (hrs)		0–2	2–4	4–6	6–19	19–24	Total
C^{14} in expired CO_2	Rat 1	7.2	10.2	8.6	20.6	4.3	50.9
	Rat 2	6.4	13.7	7.7	24.2	4.5	56.5

* The values recorded are percentages of the total injected radioactivity.

In the first 2 hrs approximately 7% of the injected C^{14} was found in the expired CO_2, and at the end of 24 hrs about one-half of the radioactivity was exhaled. The maximum rate of $C^{14}O_2$ exhalation was observed between the 2nd and 4th hrs. These results indicate that about one-half of the administered palmitic acid had been metabolized in 24 hrs.

The data presented here justify the conclusion that emulsified fat introduced directly into the blood stream is available for caloric purposes. Further evidence that parenterally administered emulsified fat pursues a normal metabolic path was provided by the finding that about 50% of the injected C^{14}-labeled fatty acids recovered in the liver had been incorporated into phospholipids at the end of 24 hrs.

[1] This investigation was supported by a grant from the American Cancer Society (recommended by the Committee on Growth) and the Cutter Laboratories.

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Life Cycle of *Postharmostomum laruei* McIntosh 1934 (Trematoda: Brachylaemidae)

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The adult trematode, *Postharmostomum laruei* McIntosh 1934 (Brachylaemidae), has been experimentally developed in this laboratory in the deer mouse, *Peromyscus maniculatus* (various subspecies), as the final host.

McIntosh (*1*) described the adult, specimens of which he obtained from the cecum of the chipmunk, *Tamias striatus lysteri* (Richardson). The metacercaria and adult of this species were described by Miller (*2*) in an abstract of an unpublished doctoral dissertation, in which he named this species *Brachylaima (Postharmostomum) sexconvolutum*. An examination of Miller's thesis, however, shows conclusively that his material included at least two species. Apparently aware of the synonymy and without referring directly to his published abstract, Miller (*3*) reported on the growth rate of this parasite, now referring to it as *Postharmostomum laruei* McIntosh.

My interest in the completion of the life cycle of this species was aroused when the metacercarial stages of the parasite were encountered repeatedly during examination of land snails in the vicinity of Ann Arbor, Michigan. The metacercariae are found within the pericardial cavity of the following land snails: *Anguispira alternata, Polygyra thyroides, P. profunda, P. multilineata, P. fraudulenta, P. hirsuta, Gastrodonta ligera,* and *Zonitoides ar-*

[1] Contribution from the Department of Zoology, University of Michigan, under the direction of Dr. George R. LaRue.

boreus. In slugs, too, the metacercariae occur within the pericardial cavity. Only two species of land snails thus far examined (*A. alternata* and *P. fraudulenta*) harbor this species to the exclusion of all other brachylaemids. The number of metacercariae found within the pericardial cavity varies from one to many. Particularly in *A. alternata*, the number per snail is frequently above 50, and one snail contained 83 fully developed metacercariae. In general, metacercariae within the pericardial cavity may be divided into three recognizable age groups. Those fully developed are ovoidal, with well-established genital fundaments and exhibiting little or no movement. Very young metacercariae are characterized by the presence of a rudimentary tail, whereas intermediate forms are more elongate and tailless and show a considerably greater motility. All specimens differ from other members of the family found in snails in this area by the lack of ciliated excretory tubules. All three age groups may be present within the pericardial cavity of the same snail, indicating that immunity to the cercariae is not established following infection.

Observation showed that entrance of cercariae to the pericardial cavity occurs via the respiratory aperture, From this point, they are assumed to migrate through the excretory duct to the kidney and thence, by way of the renopericardial connection, to the heart chamber itself. Growth of metacercariae is extremely slow; feeding experiments in progress show that at 18 weeks the metacercariae have not yet reached full size.

When fully developed metacercariae were fed to laboratory-reared *Peromyscus*, adults of varying ages were secured from the cecum of the host. Attachment to the cecal walls and ingestion of blood commence within a very few hours after feeding. Adult flukes have been maintained in *Peromyscus* for as long as 100 days. Egg production commences on the 8th or 9th day, while fully embryonated eggs appear in the feces about the 20th day. All attempts at securing discharge of eggs from living worms have been unsuccessful.

Published data dealing with members of this family have shown a conspicuous lack of information concerning the miracidial stage, primarily because of difficulties encountered in freeing the miracidia from the egg shells. Miller (*2*) concluded that the miracidial stage is nonexistent for this form. Hatching of the miracidium of *P. laruei* has been observed by me, and work is now in progress in an attempt to determine its morphology. Movement of the miracidia within the eggs can be seen after the crushed adults have been placed in saline; but emergence was noted only after the adults had been kept under refrigeration several days in normal saline and then transferred to tap water, crushed, and the eggs removed.

Eggs containing fully developed miracidia were fed to laboratory-reared specimens of *A. alternata* and various species of *Polygyra*. Branching sporocysts containing immature cercariae were found only in *A. alternata* after several weeks, while mature cercariae emerged between 3 and 7 months after exposure, depending upon temperature conditions. It is noteworthy that, although snails infected with the metacercarial stage are abundant in nature, averaging from 85 to 100% infection in localities near Ann Arbor where this parasite is found, the number of snails harboring sporocysts and cercariae is exceedingly small, since only 15 individuals of more than 3,200 examined to date by techniques involving the crushing of the snail have shown these stages. Moreover, fully developed cercariae emerged from only 5 of these 15. During the examination of a great variety of terrestrial snail hosts, sporocysts of other species of Brachylaemidae have been found, but those of *P. laruei* were found only in *A. alternata*, indicating specificity of this species of snail to infestation with the sporocyst of *P. laruei*.

A detailed account of this life cycle with complete descriptions of all stages involved is in preparation and will appear elsewhere.

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Distribution of Free Amino Acids in Mouse Epidermis in Various Phases of Growth as Determined by Paper Partition Chromatography

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This is part of a series of experiments the purpose of which is to characterize the nitrogen metabolism of mouse epidermis in various phases of growth.

In the experiments to be reported a survey was made of the free amino acids found in alcoholic extracts of whole epidermis obtained from newborn mice (0-4 and 7 days of age), from normal adult mice, and from mice receiving 3, 6, or 12 applications of methylcholanthrene in benzene or 3 applications of benzene alone. A transplantable squamous cell carcinoma originally derived from a carcinoma produced on the skin of a mouse by the application of the carcinogen was also studied. The method of treatment of the animals and preparation of the tissues has been described (*6*). The tissues were dried *in vacuo* over P_2O_5, ground, and redried to constant weight. Samples (200 mg) of the tissues studied were stirred thoroughly with 1 ml of 76% alcohol at room temperature, and determinations by the two-dimensional chromatographic method (*1, 2, 4*) were made on 75 µl of the untreated extract and on similar aliquots after oxidation with H_2O_2 and after hydrolysis with HCl. The amino

[1] Aided by grants from the Charles F. Kettering Foundation and the National Cancer Institute.

acids were identified by their relative positions on the paper square and by comparison with a reference chro-

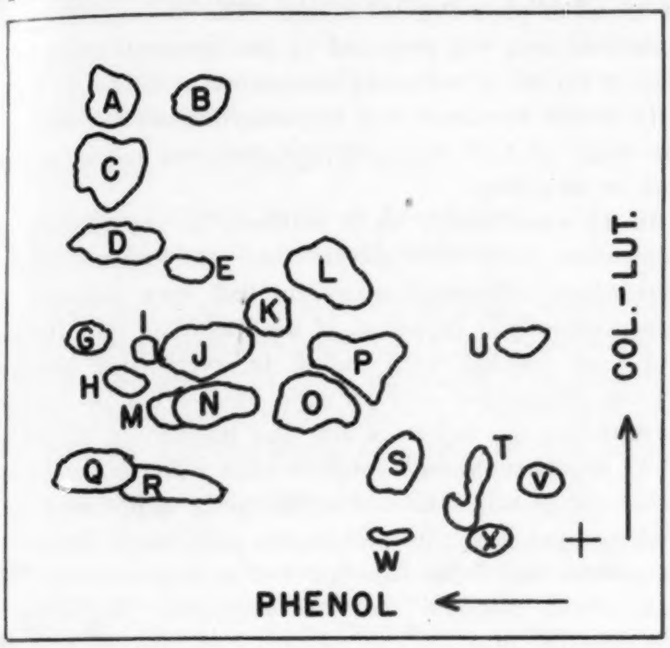

FIG. 1. Diagram of constituents of chromatograms made from epidermal and tumor extracts: A, phenylalanine; B, tyrosine; C, leucine; D, valine; E, methionine sulfone; G, proline; H, histidine; I, hydroxyproline; J, alanine; K, threonine; L, taurine; M, β-alanine or citrulline; N, glutamine or serylglycylglycine; O, glycine; P, serine; Q, arginine; R, lysine; S, glutamic acid; T, aspartic acid; U, cysteic acid; V, "oxidized" glutathione; W, "underglutamic acid," unidentified; X, glutathione.

matogram prepared by Dent (*3*). A diagram showing the positions of the ninhydrin-reactive substances found in the samples is shown in Fig. 1. Spot X was given by

FIG. 2. Peroxide-treated extract of epidermis after 6 paintings with methylcholanthrene in benzene.

glutathione either in pure solution or on addition to a casein digest. On treatment of either solution by H_2O_2, this spot was shifted to position V. It is interesting that, of these two spots, only V was observed in *untreated* extracts of all the tissues examined with the exception of the tumors, in which case only spot X was found.

In a previous investigation (*5*) it was found that the amino acid pattern of whole tumor tissue was significantly different from that of normal epidermis, but similar in most respects to that of the nonmalignant hyperplastic epidermis produced by the application of methylcholanthrene. The present study shows that the carcinoma can be sharply differentiated from the latter tissue on the basis of the distribution of free amino acids in the alcoholic extracts (Figs. 2 and 3). The tissue made hyperplastic by the application of the carcinogen and the epidermis of newborn mice had greater over-all

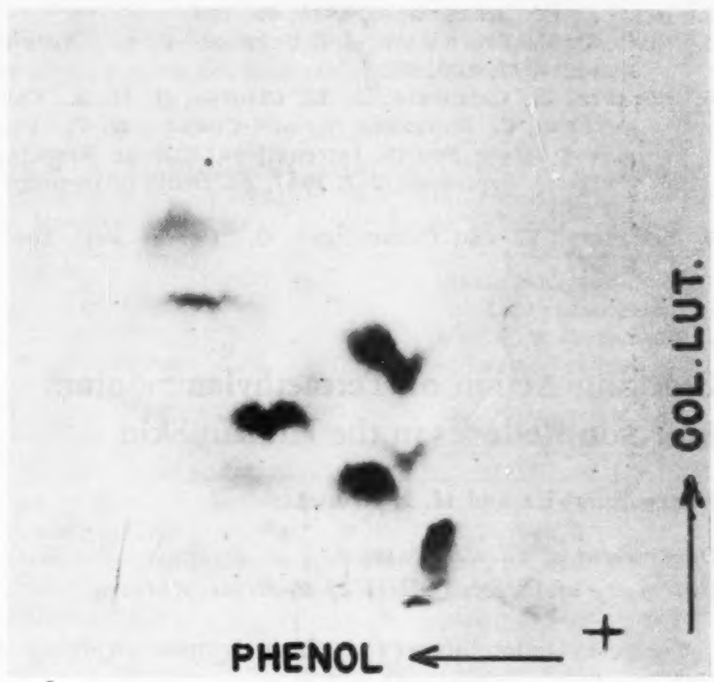

FIG. 3. Extract of squamous cell carcinomata.

concentrations of the detectable constituents than the normal adult epidermis, while the tumors showed a striking decrease. Only the "underglutamic acid" and cystine spots (the latter not appearing on this photograph) in the tumors had a greater intensity than in the other samples. The over-all decrease in free amino acids found in the tumors is even more impressive when it is recalled that a given fresh weight of this tumor contains only approximately one-half of the dry weight found in the same fresh weight of normal or hyperplastic epidermis (*6*). There was a retardation of the movement of the amino acids in the tumor extracts in the phenol direction which disappeared after acid hydrolysis. This phenomenon, which is often associated with the presence of constituents of high molecular weight, such as polypeptides, is under further investigation. The application of pure benzene produced marked increases in proline and lysine contents, a decrease in the taurine level, and little or no change in the other constituents.

The epidermis of newborn mice and hyperplastic epidermis, both of which tissues have a more rapid rate of growth than normal adult epidermis, had greater concentrations of free amino acids than the latter tissue,

while the rapidly growing carcinoma had a much lower content than normal. This suggests that the growth in the nonmalignant epidermis may be associated with the ability of the cells to increase the intracellular concentrations of the amino acids necessary for protein synthesis, whereas in the malignant tumor the mechanisms for protein synthesis are much more efficient and can operate at a greatly accelerated rate, even in the presence of smaller concentrations of amino acids.

Several aspects of this work are being studied further.

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Blocking Action of Tetraethylammonium on Axon Reflexes in the Human Skin

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Tetraethylammonium (*4*), which is now enjoying a wide trial as a diagnostic and therapeutic agent, is believed to exert its effects by the specific blockade of autonomic ganglia (*1, 2*). It is of interest, therefore, that in connection with some studies of the autonomic pharmacology of the skin we have obtained evidence that tetraethylammonium may exert an action on peripheral nerve fibers.

In most individuals the intracutaneous injection of acetylcholine in appropriate concentrations induces pilomotion and sweating, which occur very promptly after injection of the drug and extend for a considerable distance from the site of injection. These responses have been shown to be due to axon reflexes dependent on the integrity of the postganglionic sympathetic fibers (*5*).

By previously infiltrating the skin with tetraethylammonium we have been able to inhibit the axon reflexes of pilomotion and sweating induced by acetylcholine.

Pilomotion was elicited by the intracutaneous injection of 0.1 ml of acetylcholine hydrobromide, 1: 25,000; axon reflex sweating, by the injection of 0.1 ml of acetylcholine hydrobromide, 1: 500. Sweating was demonstrated by the ferric chloride–tannic acid method of Silverman and Powell (*6*). Axon sweating must be distinguished from the local response, which is confined to the area of the wheal, and from the sweating which follows the lymphatic diffusion of acetylcholine. Areas of the volar aspects of both forearms were selected for each test. The control area was prepared by the intracutaneous injection of 0.1 ml of physiological saline. The corresponding contralateral area was prepared by the intracutaneous injection of 0.1 ml of tetraethylammonium chloride, 1: 100.

It should be noted that tetraethylammonium itself, in the range of 1:10 to 1: 100,000, does not induce pilomotion or sweating.

In 15 experiments on 7 subjects in no instance did pilomotion occur when acetylcholine was injected into the spot where tetraethylammonium had been injected 1–2 min previously. Injection of acetylcholine into the control area treated with saline in every test produced typical pilomotion over an area of 2–3 cm in diameter surrounding the injection site and lasting for 45–90 sec. In 12 experiments on 8 subjects axon reflex sweating was either completely inhibited or markedly suppressed when acetylcholine was injected into the spot where tetraethylammonium had been injected 1–2 min previously. The local sweat response was not impaired. Injection of acetylcholine into the control area treated with saline in every instance produced typical axon sweating over an area of 2–4 cm in diameter.

Since these axon reflexes of the skin depend on the integrity of the postganglionic sympathetic axon and since they are blocked by the presence of tetraethylammonium locally in the skin, it is presumed that the blockade occurs along the course of the efferent sympathetic fibers in the skin.

The only other theoretically possible site of the stimulating action of acetylcholine and the blocking action of tetraethylammonium is the neuro-effector junction. In any case, there are no ganglion cells in the skin, although these axon reflexes occurring over the peripheral neural apparatus behave pharmacologically as though the site of stimulation were an autonomic ganglion. Rothman and Coon (*5*) pointed out this similarity and demonstrated that, as in the autonomic ganglia, nicotine or α-lobeline could be substituted for acetylcholine as the stimulus. The present study reveals a further similarity, namely, the blocking by tetraethylammonium of the nicotinic stimulating action of acetylcholine.

Evidence of the specificity of this blocking effect is the fact that we have been unable to inhibit with tetraethylammonium the flare which surrounds histamine-induced wheals of the skin, an axon reflex which is dependent on the integrity of afferent fibers of the skin (*3*).

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Further Consideration of a Suggested Simple Laboratory Test for Poliomyelitis Virus[1]

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A preliminary note (*1*) reported findings which suggested that an interference phenomenon may have resulted in a relative protection of mice, inoculated with material containing poliomyelitis virus, against a subsequent inoculation with the Lansing strain of virus. It was hoped that these findings might become the basis of a simple laboratory test for the presence of poliomyelitis virus.

TABLE 1

EFFECT OF PRELIMINARY INTRACEREBRAL INOCULATION OF EXTRACTS OF HUMAN STOOL OR MONKEY SPINAL CORD, CONTAINING OR FREE OF POLIOMYELITIS VIRUS, ON REACTION OF MICE TO SUBSEQUENT INTRACEREBRAL INJECTION OF LANSING VIRUS

Material injected intracerebrally 2 days before Lansing virus: Group	Type	Strain	No. of mice paralyzed or dead at indicated time after intracerebral injection of Lansing virus (1×10^{-2})*: 10 days	14 days	28 days
Presence of poliomyelitis virus in aliquot samples demonstrated by tests in monkeys	Stool	J.H.	7/10	9/10	10/10
	"	E.D.	6/10	7/10	10/10
	"	D.Y.	4/10	6/10	6/10
	"	L.W.	4/10	8/10	9/10
	Monkey spinal cord†	B.H.	5/10	6/10	9/10
	"	L.W.	5/10	5/10	7/10
	"	J.F.	5/10	7/10	9/10
	"	J.R.	4/10	6/10	9/10
	"	J.H.	3/10	4/10	9/10
No poliomyelitis virus found by tests in monkeys	Stool	....	6/10	6/10	10/10
	"	....	5/10	8/10	10/10
Normal monkey spinal cord			4/10	7/10	9/10
No preliminary inoculation Lansing virus controls	10^{-2}	Group I	7/10	9/10	9/10
		Group II	6/10	6/10	7/10
	10^{-3}		3/10	5/10	8/10
	10^{-4}		0/10	0/10	6/10
	10^{-5}		0/10	0/10	1/10

* Based on the control titer of this virus at 28 days, this dose contains 50 PD_{50} of virus.

† Strains of human origin—second or third generation in rhesus monkeys.

Since the preliminary report was based mainly upon the results obtained with extracts of 5 individual human stools collected during a single epidemic period, it was considered desirable to repeat the experiments on a larger scale with different strains of virus. The availability in the Cincinnati laboratory of a number of frozen specimens of known potency, based on recent tests in monkeys, permitted prompt repetition of this work.

The results of these tests, shown in Tables 1 and 2, indicated that (a) the incubation period among different groups of mice inoculated with the Lansing virus alone was much more variable than appeared to be the case in the preliminary tests, and (b) intracerebral inoculation of mice with strains of poliomyelitis virus of proved pathogenicity for monkeys does not interfere with the action of the Lansing strain, regardless of whether or not those strains are immunologically related to it.

TABLE 2

EFFECT OF PRELIMINARY INTRACEREBRAL INOCULATION OF THE IMMUNOLOGICALLY RELATED "MV" VIRUS ON REACTION OF MICE TO SUBSEQUENT INJECTION OF LANSING VIRUS

Series	Group*	No. of mice paralyzed or dead at indicated time after inoculation of Lansing virus 1 : 50: 10 days	14 days	28 days
0.03 cc of 20% suspension of monkey spinal cord—"MV" virus—injected intracerebrally 2 days before Lansing virus	I	5/5	5/5	5/5
	II	3/5	5/5	5/5
	III	3/5	5/5	5/5
	IV	3/5	4/5	5/5
	V	1/5	4/5	5/5
No preliminary inoculation Lansing virus controls	I	5/5	5/5	5/5
	II	4/5	5/5	5/5
	III	3/5	4/5	4/5
	IV	2/5	3/5	5/5
	V	2/5	3/5	4/5

* All mice were inoculated simultaneously with the same material and divided into groups of 5 each in order to determine the random distribution of paralysis and death in samples of this size.

The tests were also repeated in the Paris laboratory with extracts of the stools used in the original tests, and the results were similar to those shown in Tables 1 and 2—irregularity in the prolongation of the incubation period among the preinoculated mice, and greater variation than was previously observed among the controls.

The results of this work lead to the conclusion that interference with the Lansing virus in mice cannot be the basis of a simple laboratory test for poliomyelitis virus. It is also noteworthy that Sabin and Ward (*2*), who tested many strains of poliomyelitis virus of recent human origin for their capacity to protect mice against a challenge dose of Lansing virus administered 2 months after the original inoculation rather than 2 days, as in the present tests, also obtained only negative results.

[1] Aided by a grant from the National Foundation for Infantile Paralysis.

[2] National Research Council Senior Fellow in Pediatrics.

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Comments and Communications

A Note on "Why Vegetation on Watersheds?"

The writer would like to add a couple of items apparently overlooked in the recent note by Chapman Grant (*Science*, October 29, p. 486). First, watersheds that have reservoir storage for the entire annual precipitation are quite rare. In southern California a large part of the water conserved is put underground by percolation of slowly released impounded stream flow. Complete storage is unnecessary as long as the entire season's precipitation does not come at once and is not turned immediately into stream flow. It is the watershed vegetation that slows down the runoff to make storage less extensive and expensive, and that makes long-continued percolation to underground storage possible. Second, the gunited or tin-roof type of watershed has not proved desirable. Residents of the desert areas of California and along the Wasatch front in Utah have suffered severe floods from denuded watersheds. In many cases the affected communities have gone to great effort and expense to get a cover vegetation re-established. As the cover has come back, flood damage has been reduced.

Research findings show that, though vegetation does take its toll of the water supply in arid regions, the residual water is almost all usable. Where the vegetation is gone, stream runoff often becomes flood flow. Such a flow is usually entirely wasted, except for percolation underground, and, in any event, is contaminated with a heavy load of silt and debris at nearly all stages. Interested Californians might well review the watershed studies carried on by the Forest Service at the San Dimas Experimental Forest near Los Angeles.

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Antigen Films and Long-Range Forces

In a recent note (*Science*, July 30, 1948, pp. 107–108) Karush and Siegel produce evidence from electron microscope studies of deposited protein monolayers that the monolayers on glass slides are not smooth layers of uniform thickness. The protein layers are apparently irregular in thickness with ridges or peaks which, in extreme cases, may be as high as 200 A. They assume from this that when multilayers of barium stearate are deposited on this irregular monolayer, the ridges or peaks project *through* the barium stearate layers. On the basis of this assumption they challenge the necessity for specific long-range forces as postulated by Rothen (*Science*, November 2, 1945, p. 446; *J. biol. Chem.*, 1947, **168**, 75) to explain the specific interaction of an antibody with the antigen layer, through the intervening layers of barium stearate.

There is no apparent justification for this assumption of Karush and Siegel. On the contrary, it seems unlikely that the peaks of the protein layer will project through any monolayer deposited on it. It is well known that, when monolayers are deposited onto a solid plate from a liquid surface, the deposition ratio is almost exactly unity (cf. Langmuir, *et al. J. Amer. chem. Soc.*, 1937, **59**, 1751). This is true if the "solid plate" is a fine wire gauze so that the monolayer does not even follow the contours of macroscopic irregularities on the plate surface. The film is stretched across the tops of any peaks or ridges.

Karush and Siegel observed ridges which were generally between 50 and 85 A high, and there is therefore no reason to suppose that these would have any effect on a monolayer deposited on the protein film. If the protein film is ridged, it means that the bulk of the protein will be even farther away from the antibody than is indicated by the thickness of the "barrier" layer.

If the explanation of Rothen's results is to be found in some penetration of the barrier by antibody or antigen molecules, then a more probable mechanism could be provided by the crystallization of the barrier layers. Multilayers usually form microcrystals which are continuous through the thickness of the multilayer, and so there will be intercrystalline boundaries extending from top to bottom. It is conceivable that one or more active groups of the antibody could penetrate at one of these boundaries. It does not seem necessary for the initial "hole" in the barrier to be large enough for a complete antibody molecule to get through. If a particularly active group can approach near enough to the antigen, it is possible that the forces brought into play are large enough to extend the "hole" so that a considerable amount of antibody could then penetrate the barrier.

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Precedence of Modern Plant Names Over Names Based on Fossils?

James M. Schopf has proposed an amendment to the International Rules of Botanical Nomenclature to the effect that names based on recent material should always take nomenclatural precedence over names based on fossil or subfossil specimens (*Science*, April 2, 1948, pp. 344–345). "Always," in this connection, obviously means even that the law of priority may thereby be violated. In *Science* (October 29, 1948, p. 483) the author reports a "generally favorable" reception of his proposal.

Both proposal and reception seem deplorable from a strictly nomenclatural point of view. They seem to be based on the "natural but mistaken assumption that types are somehow typical, that is, characteristic of the groups in which they are placed," and on the fact that "types . . . are by many students supposed to be not only name-bearers but also the bases on which group concepts are erected and the standards of comparison for those concepts" (Simpson. *Bull. Amer. Mus. nat. Hist.*, 1945, **85**, 29). The primary and only function of types, how-

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ever, is name-bearing; this makes strict adherence to the law of priority imperative. Therefore, substitution of a new type species of a genus for an already established one, as suggested by Schopf, e.g. in the case of *Metasequoia*, is not only not permissible under existing rules[1]—as he agrees—but even if it were to be permitted by an amendment, it would be bound to create confusion.

Unconsciously Schopf, himself, gives an example of such confusion (p. 483): Should the living and the fossil *Metasequoia* prove to be really congeneric—a fact not yet established beyond doubt, according to the author—and should, furthermore, his above proposal be accepted and incorporated in the Rules, then, he suggests, the genus "should be cited for type reference as *Metasequoia* Hu and Cheng, *non* Miki." However, such a way of citing has always implied, and obviously still implies, that Hu and Cheng (the authors of the living *Metasequoia*), on the one hand, and Miki (the creator of the genus *Metasequoia*, based on a fossil species), on the other, applied the same name to two different genera, whereas in the present case the species to which both authors apply this generic name are congeneric, according to Schopf's own premise. Thus, the same name means also the same thing. It would seem that no better *reductio ad absurdum* could be thought of for Dr. Schopf's proposal.

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The Human Engineering Seminar at New York University

Readers of *Science* are likely to be interested in learning about a pioneering effort in the cross-fertilization of ideas from many scientific fields which is currently being made in the College of Engineering, New York University. The present Seminar in Human Engineering, which is a continuation of a more informal series of sessions held during the spring of 1948, is sponsored jointly by the College of Engineering and the Institute of Industrial Medicine of the College of Medicine.

Human engineering, as conceived by the seminar participants, is a rapidly expanding branch of applied science which is concerned with the general problems of the interactions of men and machines. The emerging science of human engineering, which others have referred to as biomechanics, biotechnology, and psychophysical systems research, draws heavily upon the experimental techniques and data of engineering, the biological sciences, the medical sciences, psychology, and certain of the social sciences, notably anthropology, all of which are concerned with the conditions under which man works and the factors associated with optimal performance with machines.

Sessions of the Human Engineering Seminar have attracted representatives from virtually all of the the professions whose mutual interests find expression in the seminar. Each session, although devoted to a consideration of a limited segment of the field of human engineering, has proved useful to various professionals in attendance in suggesting ways in which the data and principles from another science can be applied to the study and evaluation of problems in their area. Among those attending the meetings there has developed a deepened appreciation for the cross-disciplinary approach which characterizes the papers presented, and this appreciation is grounded in the experience of learning to think within the framework of an often alien point of view.

As a result of a number of seminar sessions, the major problems and issues of human engineering have begun to emerge and to clarify themselves, and there is a growing acceptance among participants of the need to fashion practical working procedures for the team approach to the resolution of pressing research problems from many sciences which find concrete expression in this field.

To indicate the trend of thinking among seminar members, it is useful to glance at the broad areas which have been considered. Arthur Lefford, of the College of Engineering, presented a psychological approach to "The Present Status of Fatigue," in which there was a serious effort to understand problems of fatigue within the context of motivation as a psychological process. "An Over-All View of Personality for the Human Engineering" sought to advance the notion that in human engineering research man has for too long been considered either a machine or machine-like, and that it is time now to concern ourselves with the attitudes, motivations, and other personality characteristics and processes of men in relation to the design and operation of machines.

The session on "Environmental Factors in Human Engineering," led by Norton Nelson, of the College of Medicine, New York University, sought to present facts and principles from physiology which have a direct bearing upon human engineering research inquiries. Although devoted to certain selected problems in the thermodynamics of human behavior, the presentation suggested clearly the broad values of the physiological approach to human engineering. Matthew Luckiesh, of the General Electric Lighting Research Laboratory, in his paper, "The Human Seeing Machine," sought to make clear the enormous number of problems confronting the illumination engineer in a consideration of even the simplest human engineering inquiry in the area of illumination.

Other papers on "The Present Status of Principles of Motion Economy" and "Anthropometric Data in the Design and Operation of Machines and Equipment" highlight other interests of seminar members. These and other papers presented before the Human Engineering Seminar have been informally published as "Contributions to Human Engineering" and are already finding use in the work of those who ally themselves and their research with the human engineering point of view which the Seminar has sought so earnestly to develop.

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[1] Analogy with neotypes for species whose original type has been lost or destroyed would not be justified, even if the situation were similar, which it is not; for the types of species are physical specimens, but those of genera are species, which are mental concepts.

In Memoriam

Richard Chace Tolman

1881-1948

Richard Chace Tolman, professor of physical chemistry and mathematical physics at the California Institute of Technology and dean of the Institute's Graduate School from 1934 to 1946, died September 5, 1948, in Huntington Memorial Hospital, Pasadena, at the age of 67 years, from pneumonia following a stroke which he had suffered on August 14. For more than a quarter-century one of the great leaders in the intellectual life of the California Institute, for more than a decade at different times scientific agent or adviser to the Government in critical problems, Dr. Tolman was, through the comprehensive versatility of his mind, not merely an expert student of relativity, thermodynamics, and other equally abstruse fields, but a theoretician of the structure of the universe the breadth and acumen of whose concepts had led to his being numbered among the world's greatest cosmologists.

He was born in West Newton, Massachusetts, March 4, 1881, and took his B.S. degree in chemical engineering from the Massachusetts Institute of Technology in 1903. The following year he spent in Germany, part at the Technische Hochschule at Charlottenburg, Berlin, and part in an industrial chemistry laboratory at Crefeld. Returning for graduate study at the Massachusetts institution, he served as research associate in theoretical chemistry for two years and in physical chemistry for two years thereafter, receiving the doctorate in 1910. After service in chemistry on the faculties of the Universities of Michigan, Cincinnati, and California (Berkeley), he was called to a professorship of physical chemistry at the University of Illinois in 1916.

During the first World War as chief of the Dispersoid Section of the Chemical Warfare Service, and after the war as associate director and director of the War Department's Fixed Nitrogen Research Laboratory, Dr. Tolman made his first participation in scientific affairs for the Government in time of emergency. Of marked importance in its own right, this was significant foreshadowing of the still greater contributions which he was to make years later in even more urgent circumstances.

From his War Department responsibilities Dr. Tolman went to the faculty of the California Institute of Technology in 1922, where for nearly two decades he was to have uninterrupted opportunity for the studies which brought him world prominence in science and for important and creative work in clarifying the interrelations between physics and chemistry, contributing thus to the breaking down of compartmentalization and to the consolidating of knowledge. Completing at the California Institute the elegant solution of the problem of experimentally measuring the inertia or mass of the electron which he had begun at Berkeley, he went on to a wide range of work in statistical mechanics, relativistic thermodynamics, and cosmology. In all these fields his contributions were of fundamental and lasting significance, as is well exemplified by his classic *The principles of statistical mechanics,* which appeared in 1938.

This period of rich productivity was not permitted to continue; in June 1940, foreseeing the crisis that lay ahead for the United States, Dr. Tolman came to Washington to offer his services to his country. For the next six years he was to have a primary responsibility in the joined efforts of science, industry, and the military which were essential to, and successful in, preserving the free way of life. He served as vice-chairman of the National Defense Research Committee from its inception and had special cognizance of problems of armor and ordnance. He played a very important role in the early inspiration that led to development of the proximity fuse and of rockets. Throughout the arduous and complex undertakings which led to the development of atomic bombs his knowledge and acumen were of the first order of importance. Not only did he serve as scientific adviser to Gen. Groves from the establishment of the Manhattan District and as U. S. adviser to the wartime Combined Policy Committee, but once the bombs resulting therefrom had put an end to the war, he became chief technical adviser to Mr. Baruch, U. S. representative to the United Nations Atomic Energy Commission, in its endeavors to develop sound means for control of the weapon and development of the peaceful uses of atomic energy. In these exacting assignments he was in the highest sense a scientist-statesman. The U. S. Medal for Merit and the rank of honorary Officer of the Order of the British Empire came to him in recognition of that fact.

Of profound scholarship and unsparing intellectual rigor, Richard Tolman was, in addition, a man of great wisdom and personal kindliness. Outstanding as

was his ability in research, it was more than equaled by his skill in teaching, and that, as always, was owed to wisdom and kindliness. In his own being he combined the ethical insight and scientific intelligence on which, taken together, he based his faith, declared at Brown University in 1947, "that the control of evil is possible. I am sure," he said in that address, "that humanity will continue to encounter great troubles, but I do not think that civilization will destroy itself. To surmount our troubles, we shall need courage, and patience, and clarity of thought, and sincerity in the advocacy of fair and reasonable courses of action. For these virtues we may pray, each in his own fashion."

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Book Reviews

Cancer, I, Hérédité, hormones, substances cancérigenès. J. Maisin. Paris: Casterman, Tournai-Paris, 1948. Pp. 248. 84 fr.

In the Introduction the author states that he has written this book for intellectuals not specialized in the cancer problem, although he hopes that the physician and even the cancerologist may draw some benefit from reading it. This statement alone suffices to explain the high qualities of the book. For if an intellectual from a field writes for another intellectual from another field, he will, naturally, maintain his subject on a plane high enough while avoiding tedious detail and an excess of technicalities. On the other hand, since he can rely on the receptiveness of mind of his reader and his general background, he will try to go to the essence of the facts and the biological problems therein involved. By doing so, these problems detach themselves from the strict branch of science from which they have emerged and become universal biological problems. Dr. Maisin has fully succeeded in making himself understood by another intellectual, and his hope of capturing the interest of the specialist has been fulfilled.

Whatever should be known of the work done on cancer in order to understand future developments is succinctly given in the first pages of the book together with pertinent historical data. The author then goes into a complete survey of the three main subjects of this volume: the relation of cancer to, first, heredity; second, hormones; and third, certain chemical substances called carcinogens. This he does brilliantly.

We are all aware of the appalling number of significant contributions to these subjects during the last 20 years. All of them are reviewed by the author, and the references are appended in an orderly fashion. The author does not list these coldly, leaving to the reader the task of drawing his own conclusions on the basis of the raw material displayed. The reader is constantly helped in this task by the author, who selects the facts, uses the right adjectives to qualify them, and often gives his own opinions on the problems, to many of which the School of Louvain has actively contributed.

One notes in the book the predominance of American literature, especially during the last 8 or 10 years. Interesting contributions from Europe have appeared, however, even during the war, and those from France and Belgium are not generally known among American cancerologists. Inclusion of these still further enhances the value of the book.

In several ways Maisin's book reminds one of that written by Charles Oberling and published in 1942. This book, which was translated into English, has been avidly read and has had a decided influence on many minds. The same should be done with Maisin's book following publication of the second volume.

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Outlines of physical chemistry. Farrington Daniels. New York: John Wiley; London: Chapman & Hall, 1948. Pp. viii + 713. (Illustrated). $5.00.

As Prof. Daniels states in his preface, *Outlines of physical chemistry* is to be regarded as the first edition of a new book. The high standards set by Getman and by Getman and Daniels in their previous well-known and widely used texts on physical chemistry have been maintained, but progress in research in physical chemistry required a rewriting rather than merely a revision.

The author's point of view is perhaps best presented by quoting a statement from the introductory chapter: "Usually science progresses by inductive reasoning from a few facts, follows with deductive reasoning based on the hypotheses, and, finally, tests by experimental measurements designed to prove or disprove the theoretical deduction. Many hypotheses are destined to be discarded when new facts and more precise data are obtained, but they fulfil a very necessary function in the development of science. A successful hypothesis is not necessarily a permanent hypothesis, but it is one which stimulates additional research, opens up new fields, or explains and coordinates previously unrelated facts. The scientist needs imagination in creating new hypotheses, but he needs also ingenuity and skill in devising experiments to test them and critical judgment in evaluating the results."

The general field of physical chemistry is covered quite completely, and it seems pointless to list the titles of the chapters. It should, however, be mentioned that in addition to the traditional topics, excellent chapters on

colloids, quantum theory, photochemistry, and nucleonics are included. Emphasis is placed on the structure of matter, and not until this fundamental groundwork has been treated is the student exposed to the more abstract thermodynamic development of the subject. Practically all the necessary mathematical derivations are given in detail in the text; only a few are relegated to an appendix for the ambitious student. The annoying tendency of many writers to overwork the phrases "it can be shown" and "obviously" does not appear.

One of the best features of this text, from the pedagogical point of view, is the liberal use of numerical examples and problems. Furthermore, these are not hypothetical cases which fail to give the student any contact with reality, but are mainly based on actual data from the literature. It is the sort of training which will best prepare the student for research work later. These problems cover the whole range of practical work from calculation of atomic weights from gas densities to determination of the rate of transmutation in an atomic pile. Another commendable feature of the book is the bibliography: references to up-to-date literature are given, and, in addition, each chapter concludes with a series of cross-references to other books for supplementary reading. It is a pleasure to recommend *Outlines of physical chemistry*, and Prof. Daniels is to be congratulated for a fine piece of work.

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Yale University

North American trees (exclusive of Mexico and tropical United States). Richard J. Preston, Jr. Ames, Ia.: Iowa State College Press, 1948. Pp. lv + 371. (Illustrated.) $4.00.

Setting as his triple target the nontechnical public, students, and scientists, the author should be credited with a near miss. For the nontechnical public and for beginning students of dendrology, this compilation of illustrations and almost telegraphic descriptions of the important trees of the United States and Canada should prove very helpful. Certainly, it will save the time of those who, in the past, have had to consult five or six important works for various geographic regions. But the scientist will wish to digest for himself the authoritative source material which the author has assimilated but failed to cite in any list of references in this volume.

Eleven pages, packed full of technical terminology and diagrams, are devoted to a *nontechnical* explanation of the "Natural Relationship of Trees" and to descriptions of the "Forest Regions of North America" and "Tree Characters." Had the frontispiece map been slightly modified to coincide with the groupings of the forest regions in the text, this subject of regions and forest types would have been even more useful.

The Keys to the Genera—the keys to the species of the genera among the gymnosperms and to those of the genera among the angiosperms—will, with the liberal use of the 9-page glossary, prove very useful indeed. However, the chief value of the book would seem to lie in the compact presentation of drawings of foliage, twig, bud, fruit, and seed characteristics in a form convenient to take into the field for direct comparison. The small distribution maps are also helpful.

The volume is recommended to those who are frequently plagued with the question: "What's that tree?"

M. A. HUBERMAN
Food and Agricultural Organization of the United Nations, Washington, D. C.

Scientific Book Register

COURANT, R., and FRIEDRICHS, K. O. *Supersonic flow and shock waves.* New York-London: Interscience, 1948. Pp. xvi + 464. (Illustrated.) $7.00.

HARRISON, GEORGE R., LORD, RICHARD C., and LOOFBOUROW, JOHN R. *Practical spectroscopy.* New York: Prentice-Hall, 1948. Pp. xiv + 605. (Illustrated.) $6.65.

MAYER, CLAUDIUS F. (Ed.) *Index-catalogue of the library of the Surgeon General's office, United States Army (Army Medical Library).* (Fourth Series, Vol. X, M-Mez.) Washington, D. C.: Superintendent of Documents, U. S. Govt. Printing Office, 1948. Pp. iv-994. $4.25 (cloth).

POLLARD, ERNEST C., and STURTEVANT, JULIAN M. *Microwaves and radar electronics.* New York: John Wiley; London: Chapman & Hall, 1948. Pp. vii + 426. (Illustrated.) $5.00.

SCHMIDT, ALOIS X., and MARLIES, CHARLES A. *Principles of high-polymer theory and practice.* New York-London: McGraw-Hill, 1948. Pp. xii + 743. (Illustrated.) $7.50.

SEWELL, R. B. SEYMOUR. *The free-swimming planktonic Copepoda: geographical distribution.* (The John Murray Expedition, 1933–34; Sci. Rep., Vol. VIII, No. 3.) London: British Museum (Natural History), 1948. Pp. 318–592. (Illustrated.) 35/–.

SMITH, AUSTIN, and HERRICK, ARTHUR D. (Eds.) *Drug research and development.* New York: Revere, 1948. Pp. xi + 596. $10.00.

(Continued from page 10.)

agreement of our findings with the predicted theory of the ultrastructure of the chromosome. The unit particles observed by us were associated with individual chromonemata. Although the particles varied in shape and size from one band to another, they had a uniform character in any one band. Their size range and density make them comparable with virus and bacteriophage particles. They are identifiable with the substance of chromomeres well known to the light microscopist. There is no doubt but that this is nucleoprotein. In view of these conclusions, it seems reasonable to believe that the discrete particles we have seen are genes.

NEWS and Notes

Marshall Brucer, assistant professor of physiology at the University of Texas School of Medicine, has been selected to direct the cancer research program of the Oak Ridge Institute of Nuclear Studies. In his new position as chairman of the Medical Division Dr. Brucer will direct a long-range program devoted to the study of the treatment of cancer and other malignant diseases, together with the training of medical and research personnel in new techniques.

Marston Taylor Bogert, professor emeritus of organic chemistry, Columbia University, and consultant and adviser to Evans Research and Development Corporation of New York City, has been appointed Charles Frederick Chandler lecturer and medalist at Columbia for the current academic year.

Frank W. Schaller, formerly associate professor of agronomy at West Virginia University, became research associate professor at Iowa State College on January 1.

Leonard F. Kellogg joined the Iowa State College faculty as professor of forestry January 1. He has been silviculturist at the Central States Forest Experiment Station, assigned to the College.

Ira A. Gould, professor of dairy manufacturing at the University of Maryland, has been appointed chairman of the Department of Dairy Technology at Ohio State University, effective February 1.

Henry W. Meyerding, professor of orthopedic surgery at the Mayo Clinic and president-elect of the U. S. Chapter of the International College of Surgeons, recently returned from Europe. While abroad he presided at the Fourth Congress of the International Society of Orthopedic Surgery and Traumatology in Amsterdam and also took part in the program. Later he gave the opening address at the Congress of the Czechoslovak Society of Orthopedic Surgery and Traumatology in Prague and was made an honorary member of that Society. He then attended meetings of the French Society of Orthopedic Surgery and Traumatology and the French Society of Surgery in Paris, where he was made an honorary member of the latter Society. Honorary membership in the Netherlands Orthopedic Association was also extended to him at a congress held in Amsterdam this year.

John W. Gowen has been named head of the Genetics Department at Iowa State College. Dr. Gowen, associated with Iowa State since 1937, succeeds **E. W. Lindstrom,** who died November 8.

O. Hobart Mowrer, research professor of psychology in the University of Illinois Graduate College, was recently appointed to the newly created post of director of the Psychological Clinic.

Edwin J. Cohn, chairman of the Department of Physical Chemistry, Harvard Medical School, has been chosen to deliver the Julius Stieglitz Memorial Lecture for 1949 at the forthcoming meeting of the Chicago Section of the American Chemical Society in the University of Chicago Kent Chemical Laboratory on Friday, January 14, at 8 P.M. Dr. Cohn will speak on "Interactions of Proteins With Each Other, With Cells, and With Smaller Molecular Components of Biological Systems."

Walter J. Peterson became head of the Chemistry Department, North Carolina State College, on January 1. Dr. Peterson, former head of the Nutrition Section of the Animal Husbandry Department, succeeds **Arthur J. Wilson,** who died November 11.

Warren Ambrose, Norman Levinson, and **Henry Wallman,** of the Mathematics Department, Massachusetts Institute of Technology, are at present on leave of absence. Prof. Ambrose, who is at the Institute for Advanced Study, and Prof. Levinson, who is at the University of Copenhagen, are both working under Guggenheim fellowships; Prof. Wallman, meanwhile, is acting as visiting professor of teletechnics at the Chalmers Institute of Technology in Gothenburg, Sweden.

W. D. Cairns, professor emeritus of mathematics at Oberlin College, is serving as part-time lecturer in mathematics at the California Institute of Technology for the present academic year.

Emil Witschi, who is on leave from the Department of Zoology, State University of Iowa, and is at present working at the University of Tübingen, has been made an honorary member of the Société d'Endocrinologie de Paris.

Visitors to U. S.

B. R. Seth, of Hindu College, Delhi, India, will be serving as visiting professor of applied mathematics at Iowa State College during the current year and will give courses in elasticity and hydrodynamics in the winter and spring quarters.

W. H. J. Fuchs, of the University of Liverpool, is serving as visiting associate professor of mathematics at Cornell University for the current academic year.

Awards

The John Scott Award, established by the Scotch chemist of the same name who died in 1816, to be awarded to "ingenious men and women who make useful inventions," was conferred December 15, at Girard College, Philadelphia, on Merle A. Tuve, director of the Department of Terrestrial Magnetism, Carnegie Institution of Washington. Dr. Tuve was named to receive the award for his outstanding contribution to the development of the proximity fuse during World War II. Former recipients of the award, which is usually in the amount of $1,000, include Madame Curie, Thomas Edison, Guglielmo Marconi, Lee DeForest, and Irving Langmuir.

Carl S. Miner, founder and director of the Miner Laboratories, Chicago, has been awarded the 1949 Perkin Medal of the American Section, Society of Chemical Industry, for the work of his laboratory in developing the furfural industry. Furfural, a

chemical derivative of oat hulls and other agricultural wastes, is widely used in the manufacture of plastics. Mr. Miner will receive the Medal January 7 at a dinner at the Hotel Commodore, New York, jointly sponsored by the Society of Chemical Industry, the New York Section of the American Chemical Society, the American Institute of Chemical Engineers, and the Electrochemical Society. His address, as the 43rd medallist, will be "Science vs. Starvation."

W. L. Waterhouse, University of Sydney, has been awarded the 1949 Medal of the Federal Council of the Australian Institute of Agricultural Science for his service to Australian agriculture during the past 10 years.

Fellowships

The RCA Predoctoral Fellowships in Electronics are designed to give special graduate training and experience to young men and women who have demonstrated marked ability in the general field of electronics, either as a branch of electrical engineering or as a part of the general field of physics.

A Fellow must be a citizen of the United States who has demonstrated ability and aptitude for advanced work and who has training in electronics equivalent to that represented by one year beyond the bachelor's degree in a university of recognized merit in this field.

Fellowships will be awarded at a regular meeting of the RCA Fellowship Board to be held in March 1949. To receive consideration for tenure during the academic year 1949–50, applications must be filed on or before *February 1*, 1949. Unless otherwise arranged, tenure will begin in September 1949.

The National Foundation for Infantile Paralysis, 120 Broadway, New York City 5, has announced the availability of a limited number of postgraduate fellowships in several fields. These include: (1) research fellowships, to be awarded in virology, orthopedic surgery, pediatrics, epidemiology, and neurology, which are intended to emphasize advanced training in the basic sciences as they apply to the particular specialty and to research, and experience in research not necessarily related to poliomyelitis; (2) clinical fellowships, which are available to physicians who wish to prepare for eligibility for certification by the American Board of Physical Medicine; and (3) fellowships, which are available to physicians for one year of postgraduate study leading to a Master of Public Health degree at a school of public health approved by the American Public Health Association.

Application and requests for further information may be made to the National Foundation at any time during the year. Awards are based on the individual needs of each applicant.

A project for the study of the fundamental principles of flameproofing has been established in the Department of Chemical Engineering, Columbia University, New York, jointly by the Textile Section of the Quartermaster Corps and the Office of Naval Research. During World War II a similar war research project, under the sponsorship of the Quartermaster Corps, was maintained at Columbia for a study of improved methods for flameproofing and, as a result of some of the work of the earlier project, it has been decided to make a more thorough investigation of the various mechanisms whereby certain fire-retardant chemicals prevent the combustion of cellulose and other types of textile fibers.

Two positions as research assistants are available in the Department of Chemical Engineering under this project. These will permit credit for the researches under the project to be acceptable for the requirements of the Ph.D. degree. The research assistantships, which are open to qualified applicants who possess a Master's degree in chemical engineering or chemistry, carry a salary of $200 per month for a 40-hour week. This would permit part-time course study in conjunction with the work of the project in order to meet the course requirements for the Ph.D. degree. Applicants interested in appointment as research assistants under the project should communicate with Prof. James M. Church, of the Department of Chemical Engineering, who is in charge of the project, stating fully their qualifications as to training and experience.

Colleges and Universities

The M. W. Welch and R. P. Welch Science Teachers Workshop at Purdue University will be dedicated in ceremonies to be held in the Physics Building January 8. Karl Lark-Horovitz, head of the Physics Department, will introduce C. H. Robertson, of the physics staff, who will speak on "The Experiment in the Teacher Training Program." Following a dinner in the Purdue Memorial Union, Louis M. Stark, manager of the School Service department of Westinghouse Electric Corporation, will give an address entitled "The Enrichment of Science Instruction."

Carnegie Institute of Technology has announced the reopening of a $4,000,000 campus building and renovation program. A $1,000,000 wing will be built onto Engineering Hall, and over $1,000,000 will be spent on a power plant and a steam and electricity distribution system. In addition, there will be extensive revamping and renovation of available space in existing buildings of the Colleges of Engineering and Science, Fine Arts, and Margaret Morrison Carnegie College. In announcing the program, President Doherty stated that not a single building had been added to the campus since completion of the original plant in the early 1900s.

Meetings and Elections

A Conference on High-Frequency Measurements will be held January 10–12 in Washington, D. C., under the joint sponsorship of the American Institute of Electrical Engineers, the Institute of Radio Engineers, and the National Bureau of Standards. In addition to tours of the Naval Research Laboratory, the Naval Ordnance Laboratory, and the National Bureau of Standards, the program will include four technical sessions—"Measurement of Frequency"; "Measurement of Power and Attenuation"; "Measurement of Impedance"; and "Measurement of Noise, Antenna Measurements." The auditorium of the Department of Interior has been made available for these meetings. Those planning to attend the sessions must register Monday morning, January 10, at the Roger Smith Hotel, head-

quarters for the conference. Chairman of Local Arrangements is Harold Lyons, National Bureau of Standards, Washington D. C.

The American Society of General Physiologists is holding its next regional meeting on February 5 at New York University, Washington Square, under the auspices of the Biology Department of the Graduate School. The main speakers will be Keith Porter and Parker Vanamee, Robert Chambers, Harold Blum, Eric Ponder, Curt Stern and Alexander Sandow, and Arthur J. Kahn, and all the papers will deal with cell structure and function.

A Symposium on Molecular Structure and Spectroscopy will be held at the Mendenhall Laboratory of Physics, Ohio State University, June 13 through June 17, 1949. The interpretation of molecular spectroscopic data as well as methods for obtaining such data will be discussed, and there will also be sessions devoted to those phases of spectroscopy of current interest. A dormitory will be available for those who wish to reside on the campus during the meeting. Further information and copies of the program when they become available may be obtained by writing to Prof. Harald H. Nielsen, Mendenhall Laboratory of Physics, Ohio State University, Columbus 10, Ohio.

At the 286th anniversary meeting of the Royal Society, held November 30, the following officers and members of the Council were elected for the ensuing year: Sir Robert Robinson, president; Sir Thomas Merton, treasurer; Sir Edward Salisbury and D. Brunt, secretaries; E. D. Adrian, foreign secretary; J. D. Bernal, G. R. Cameron, Sir James Chadwick, S. Chapman, H. Davenport, Sir Frank Engledow, W. E. Garner, A. C. Hardy, C. H. Kellaway, G. F. Marrian, Sir William Stanier, H. G. Thornton, C. E. Tilley, A. E. Trueman, and S. Zuckerman, members of the Council. Sir Alfred Egerton, having completed 10 years as physical secretary, is succeeded by D. Brunt.

A Symposium on the Quantum Requirement in Photosynthesis was held December 18 on the University of Illinois campus. Oswald Tippo, chairman of the Department of Botany, reports that the participants included Farrington Daniels, of the Department of Chemistry, University of Wisconsin; J. F. Stauffer, of Wisconsin's Department of Botany; Otto H. Warburg, director of the Kaiser Wilhelm Institute of Cell Physiology, Berlin, and now visiting professor at Illinois; R. Rieke, Department of Physics, Purdue University; Barry Commoner, Department of Botany, Washington University, St. Louis; Martin Kamen, Institute of Radiology, Washington University; C. S. French, director, Carnegie Institution Laboratory of Biology, Stanford, California; Allan H. Brown and A. W. Frenkel, Department of Botany, University of Minnesota; Hans Gaffron, Department of Chemistry, University of Chicago; and Robert Emerson, Eugene Rabinowitch, and Victor Schocken, of the Photosynthesis Project, Department of Botany, University of Illinois. This symposium was arranged to discuss the discrepancies which have been reported in the quantum requirement of photosynthesis. According to Dr. Tippo, Dr. Warburg has found that 4 quanta are required, while Prof. Emerson and other American workers find that 10–12 quanta are required.

The symposium was followed by a series of critical experiments performed by Drs. Warburg and Emerson during the Christmas holidays. Dean Burke, National Cancer Institute, Bethesda, Maryland, and J. Z. Hearon, Department of Physiology, University of Chicago, were invited to the campus as scientific observers.

The Technical and Scientific Book Publishers Group of the American Book Publishers Council, Inc., at an informal meeting in New York City on December 1, unanimously re-elected the following officers: Francis M. Turner, Reinhold Publishing Corporation, chairman; Maurits Dekker, Interscience Publishers, Inc., vice-chairman; and Ralph L. Newing, International Textbook Company, secretary.

NRC News

The needs of the American Type Culture Collection is the subject of a study being made by a Committee of the National Research Council. The ATCC maintains pure "type" cultures of many microorganisms and furnishes these to laboratories, hospitals, universities, and industries. With a limited income inadequate for its maintenance at the present time, the ATCC has been faced with the prospect of discontinuing or greatly restricting its functions and services. The new NRC Committee will attempt to develop a long-range plan for the support of the Collection on a permanent basis. The membership of the Committee is as follows: Henry Welch, chairman; Robert D. Coghill, George W. Irving, Kenneth B. Raper, Roger D. Reid, Waldo L. Schmitt, Joseph Smadel, Nathan R. Smith, and Norman H. Topping.

Meanwhile, there is urgent need for support of the ATCC for the year 1949 from organizations and individuals who are aware of the necessity of pure type cultures in the standardization of products, in research, and in teaching. Contributions to the ATCC may be sent to the National Research Council, National Academy of Sciences Building, 2101 Constitution Avenue, N. W., Washington 25, D. C., for use at the direction of the NRC Committee.

Deaths

Carl V. Woodbury, 71, professor and head of the Physics Department, Norwich University, died December 13 in Northfield, Vermont. A Norwich faculty member for nearly 50 years, Dr. Woodbury had at one time also served as acting president.

Victor Kurh, 66, professor of philosophy at the University of Copenhagen, died December 15 in Copenhagen, Denmark.

John Franklin Daniel, 3rd, 38, professor of practical archaeology at the University of Pennsylvania and editor-in-chief of the *American Journal of Archaeology*, died of a heart attack December 17 at Ankara, Turkey.

Philip S. Winnek, 40, head of the Chemotherapeutic Research Department of the Maltine Company, Morris Plains, died in Morristown Memorial Hospital, Morristown, New Jersey, on December 18. As a former research chemist for the American Cyanamid Company, Dr. Winnek played a large part in developing the drugs sulfadiazine and sulfaguanidine.

Hugh Scott Cumming, 79, retired Surgeon General of the U. S. Public Health Service, died December 20 in Washington, D. C. Of the more than 40 years that Dr. Cumming was associated with public health work, he served as Surgeon General for 16 and directed the Service's growth from a comparatively unknown section of the Treasury Department to a bureau employing over 1,000 physicians. Recipient of many foreign honors, Dr. Cumming had also served as president of the Pan-American Sanitary Bureau.

Frank M. Huntoon, 67, author and former bacteriologist at the Cornell University Medical College, died December 21 in Syracuse, New York.

The American Museum of Natural History has just announced the return of the first major American expedition to remote Cape York Peninsula in Australia. This 1948 Archbold Cape York Expedition was sponsored by Richard Archbold, research associate of the Museum. Extensive and significant collections of mammals, plants, reptiles, and insects were made during the 7 months spent in the field. Among the 1,500 mammal specimens representing more than 50 species are bizarre spiny anteaters, unusual ''flying mice,'' and a specimen of the elusive Bennet's tree-climbing kangaroo. Also included in the collections are 11,600 specimens of plants which are believed to be the first representative collection of plants of far northern Australia ever brought to this country.

A new scientific journal, aimed to provide southeastern engineers and scientists with their own medium for attacking common problems and recording research results, is to appear in January. Recording technological progress in 11 southeastern states, *The Journal of Southeastern Research* will be edited by H. McKinley Conway, Jr., according to the announcements from the Southeastern Research Institute, Inc., Atlanta, Georgia. Serving on the Advisory Board will be Dean O. V. Adams, Texas Technological College; Luis H. Bartlett, director, Engineering Experiment Station, Louisiana State University; J. W. Beams, chairman, Physics Department, University of Virginia; Dean George W. Branigan, University of Arkansas; J. H. Coulliette, director, Industrial Research Institute, University of Chattanooga; Dean Paul M. Gross, Duke University; Albert H. Holland, Jr., director of research and medicine, Oak Ridge National Laboratory; Dean Roger P. McCutcheon, Tulane University; E. B. Norris, director, Engineering Experiment Station, Virginia Polytechnic Institute; J. Stanton Pierce, head, Chemistry Department, University of Richmond; Wm. G. Pollard, director, Oak Ridge Institute for Nuclear Studies; Herman M. Roth, chief, Physics Research Division, Oak Ridge National Laboratory; Walter M. Scott, director, U. S. Department of Agriculture Southern Regional Research Laboratory; and Wm. G. Van Note, director, Engineering Experiment Station, North Carolina State College.

A history of the development of radar, prepared by the Office of Scientific Research and Development, under the direction of Henry E. Guerlac, now of Cornell University, is available to the public, according to a recent announcement by John C. Green, director of the Office of Technical Services, Department of Commerce. The 1,300-page *History of radar* in four parts may be inspected at the Library of Congress, Government Publication Room, and photostatic or microfilm copies may be obtained from the Library. The four parts, with prices for photostatic and microfilm copies, respectively, are: PB 93618, $53.75, $9.00; PB 93619, $55.00, $9.00; PB 93620, $43.75, $9.00; and PB 93621, $13.75, $4.50.

Establishment of a radioisotope unit has just been authorized by the Veterans Administration at the VA Hospital in Nashville, Tennessee. Research work planned at Nashville will be directed toward developing improved methods for clinical diagnosis and medical treatment of veteran-patients. Radiophosphorus, -sodium, -iron, and -iodine will be used initially in the work. George R. Meneely, assistant chief of medical services at the Hospital, who has had wide experience with the use of radioisotopes, will direct the work of the unit.

Brookhaven National Laboratory has announced the availability of reports on the Symposium on Radioiodine (BNL–C–5), held July 26–30, 1948, and the Conference on the Chemical Effects of Nuclear Transformations (BNL–C–7), held August 19–20, at prices of $1.50 and $.25, respectively. Checks or money orders should be made payable to Brookhaven National Laboratory, and requests should be directed to the Information Group, Information and Publications Division of the Laboratory, Upton, New York.

Correction: In ''Radiocardiography: A New Method for Studying the Blood Flow Through the Chambers of the Heart in Human Beings,'' by Myron Prinzmetal, et al. (*Science*, September 24, p. 340), credit for the design and construction of apparatus should have been given Dr. Burton F. Miller instead of Dr. Robert Miller (footnote 2).

Make Plans for—

American Physical Society, Division of High-Polymer Physics, January 27–29, Columbia University, New York City.

5th Annual Conference on Protein Metabolism, January 28–29, Rutgers University, New Brunswick, New Jersey.

California Mosquito Control Association, joint conference with American Mosquito Control Association, February 6–9, Claremont Hotel, Oakland, California.

Recently Received—

Nutritional Observatory. Published quarterly and distributed gratis by the H. J. Heinz Company, Pittsburgh 30, Pennsylvania.

The calcium requirement of adults. (Borden's Review of Nutrition Research, Vol. IX, No. 9, November 1948.)

Dyelines and Bylines. An informal pamphlet published monthly by the American Cyanamid Company.

Annual report of the Public Health Research Institute of the City of New York, Inc., July 1, 1947–June 30, 1948.

Monsanto Magazine, December 1948. Published by Monsanto Chemical Company, St. Louis, Missouri.